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PREFACE

The Second Annual USAF Sanitary and Industrial Hygiene Engineering Symposium convened at Vandenberg AFB, California on 9 October 1963 for a period of four days. Approximately 125 military and civilian personnel from Air Force bases throughout the United States as well as private industry were in attendance. These proceedings contain the formal papers presented at this symposium.

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RESPONSE TO THE WELCOMING ADDRESS

Brigadier General A. A. Towner, MC
Surgeon, Strategic Air Command
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It gives me great pleasure to add my welcome to those of General Preston and Colonel Mills on your visit to one of SAC's busiest bases. We in SAC are indeed happy to be your hosts for several reasons. Foremost among these is the fact that we employ more Sanitary and Industrial Hygiene Engineers than any of the other Major Air Commands; the contributions engineers are making in our aerospace medical programs are well recognized; and here at Vandenberg AFB; especially those of you who are not associated with SAC, will have the opportunity of seeing, and perhaps get a little better appreciation of the weapon systems now coming into being.

The introduction of missiles into our arsenal of weapons is causing more and more people to become cognizant of terminology and problems areas which have been familiar to some of you for many years. Fuels quite different from JP and gasoline, which were standbys for many years, are now being used. Others will undoubtedly follow as the years pass and new systems which are presently only the figment of someone's imagination are developed. It has always been of interest to me to observe the large number of experts who suddenly appear with ready answers to any and all problems when changes in procedures such as we are now witnessing are developed and used. In SAC we shall continue to stress the responsibilities of the medical service and particularly the physician and engineer in resolving our aerospace medical problems.

But even with ourselves it is necessary that we stop and take inventory of just what is going on about us. Reviewing briefly, in retrospect, let us examine some recent developments. Not too many years ago it required nearly 10 years to develop a major weapon system. Changes in management tools have reduced this by a factor of more than two.

Today, the facilities which support the weapons are completed concurrently with the development of the weapon. To keep pace with these rapid changes, it is necessary that we in the medical service become thoroughly familiar with the techniques being employed in this process, keep abreast of the materials, procedures, and manpower to be utilized in the operation of the system in order that answers to problem areas which arise are obtained by the time the weapon system becomes operational. This is particularly pertinent to the Commands responsible for the development of the system, its use, and the logistic support manager. Existing Air Force regulations

outline the procedures for each agency to provide its input to the Systems Project Officer. Consequently, the medical service must discharge its responsibility by actively participating with other directorates whose primary interests are operations, maintenance, and other support functions. Unless this is done the medical service is failing in two respects, (1) by not discharging its responsibilities, as delineated in existing Air Force regulations, manuals, etc., and (2) by denying the commander and his staff the technical knowledge and assistance in technical areas foreign to them. In SAC we are using increasing quantities of cryogenics, ammonia, nitrogen, helium, RP 1, plus the other fuels related to our aircraft. Shortly we will have solid propellants as well as the storables. The latter are presently our primary concern. Even though some of the material has been used in missile operations for more than 10 years, toxicological data is not complete. Problems relating to the disposal of these chemicals are still with us and unless techniques for their safe handling and disposal are devised, adverse public reaction due to loss of aquatic and other wild life; the contamination of water resources; and undoubtedly claims for damages may occur.

Other recent changes and additions to our operational procedures include the increased use of radioactive materials both in medicine and industrial applications. Higher powered X-ray machines as well as accelerators are finding applications, and only recently the Air Force acquired its first reactor as a source of electric power. With the present research and activity applied to space systems it is not unrealistic to presume that sooner or later these may well be a part of our weapon systems. Just what other techniques may be adapted to military application is wide open for speculation. Only recently General LeMay indicated that a type of ray capable of projection over long distances may be a matter for consideration.

I well recognize that what I have just said is well known and understood by many of you. I restate it, however, since it emphasizes to me the many areas that engineers such as yourselves have distinct opportunities to make valuable contributions to the medical service, and more particularly the Air Force, in arriving at solutions to the many knotty problems with which we will be faced in making these instruments safe for the personnel who use them, as well as the ground crews who provide support services. The challenges and opportunities for medical contribution to the changing concepts of Air Force operations during this decade in my opinion exceed those of any previous period, as well as the immediate ones to follow. The challenge is yours and I in turn challenge you to accept it.

One word of caution I would leave with you in this matter of communications. Failure to talk with one another or to pass on information seriously deteriorates any program. One of our major problems today is to develop a means

whereby research and other pertinent data can be rapidly disseminated to those who have a need for it.

The program for your symposium has been developed to reflect on at least some of the areas indicated above. Whether or not the subject matter discussed is pertinent to your particular needs, the fact that you have these few days to meet with your co-workers, and to have the opportunity to discuss mutual problems, should permit you to return to your respective bases with renewed vigor and enthusiasm.

Again let me assure you that it is a pleasure for SAC to have you as our guests. Your hosts will do everything within their capabilities to make your stay a pleasurable and profitable one.

THE USAF AEROSPACE MEDICINE PROGRAM

Major General A. L. Jennings, USAF, MC

According to Air Force Regulation 20-28 the mission of the USAF Medical Service is "to provide the medical support necessary to maintain the highest degree of combat readiness and effectiveness of the Air Force." Traditionally, military medicine has been concerned with three broad areas in meeting this mission requirement. These include, as you know, the medical measures for selection of personnel, those for the care and treatment of the sick and wounded, and those designed to minimize the effects of the military environment on health, by preventing disease or injury. Because of our specificity of interest in our own professional specialties and activities, the interrelationship which exists among all those functions may sometimes be obscured.

In our forthcoming Air Force Manual 161-2, "Aerospace Medicine Program," the objective of this element of Air Force capability is stated as the promotion and maintaining of the physical and mental health of Air Force personnel through the application of the principles of flight medicine, military public health and occupational medicine. While this program is oriented toward the preventive aspects of medical service responsibilities, the interrelationship which exists among such functions as physical examinations to determine capabilities to perform job requirements, the diagnosis of diseases of occupational origin, and design of environmental controls, are of such a nature as to involve the entire medical service in the Aerospace Medicine Program. The medical officer responsible for flight medicine, preventive medicine, military public health or occupational medicine, with his engineer and scientist colleagues, has the primary day to day responsibility for this task. Nonetheless, all medical service officers, regardless of their specialty or duty assignment, must be aware of the fact that military medicine to a large degree is "preventive medicine".

Engineers and scientific personnel are required to assist and advise their medical colleagues in all areas of the Aerospace Medicine Program. For convenience, we have recently divided this program into three primary functional areas, namely, flight medicine, military public health, and occupational medicine. Emphasis on and staffing for these functional areas of responsibility will depend upon the nature of the particular base or command's mission and systems. At this point it would be well to point out that the term "aerospace" as utilized in this program will apply only to those commands and installations in which there are significant aerospace operations, or in support of such operations. The term

"Aerospace Medicine Program," therefore, will not be utilized except where there are two or more types of systems such as aeronautical systems and ballistic missile systems, or space vehicle systems. No matter what organizational title is used, the broad aerospace medicine program encompasses all of the related activities necessary to meet the objectives of this element of the medical service mission.

Biomedical engineering specialists, health physicists, entomologists, and other medical scientists may be assigned to work in any of the three functional areas. In addition, where indicated, the engineers, the health physicists, and medical scientists, along with technicians required for the support of the three basic functional areas may be organized as a fourth organizational group to provide services to the three basic areas.

You are all well familiar with your responsibilities and functions as an engineer and scientific member of our physician-engineer aerospace medical team. During the course of this symposium the opportunity is afforded to you to increase your specific knowledge, to exchange information with your colleagues on mutual problems, and to obtain an insight into some of the future requirements and challenges in this important professional area. Two concerns of increased importance exist in which the engineer may play a vastly more important role in the future.

The first of these is in the development of requirements for aerospace medicine research and consideration in system development. As a corollary there is also needed greater participation by command medical service representatives with AFSC in assuring that the needs of the customer, the user command, are being adequately considered and met in the development and procurement program. Much effort in this regard has already been undertaken by SAC and the Systems Command, here at Vandenberg and in the Inglewood complex. As the Aerospace Medicine Division (AFSC) assumes increasingly greater responsibilities for technical area management and coordination with the System Program officers, translation of user requirements into research and development tasks should be facilitated. In this the engineer with industrial hygiene training should be of major assistance both in the user commands and in the Air Force System Command.

The second of these areas is the utilization of engineering skills and capabilities in support of accident reaction and accident investigation. Not only are such investigations important from the medical legal viewpoint, and as a means of determining what future measures may be taken to prevent reoccurrence, but they also are vital in the early restoration of operational capability. Unwarranted fear or concern regarding hazards following an accident may materially slow down or interfere with orderly recovery processes. Here again an outstanding opportunity exists for major contributions by the aerospace medical team.

In conclusion, as engineers you are practitioners of the arts and sciences by which the properties of matter and the sources of power in nature are made usable to man. Specialized application of this professional competence in the medical service mission is considered by the Surgeon General to be of utmost importance. You are considered to be valued members of our over-all medical service capability. All attending and participating in this conference must keep in mind their obligation to our fellow airmen by contributing those things necessary to the attainment of the highest possible level of aerospace power effectiveness.

TRI-SERVICE COOPERATION ON TOXICOLOGY PROBLEMS

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I would like to review with you this morning some of the highlights in the Air Force Toxicology and Environmental Health Program during the past 3 years - my tenure in the SGO.

Late in 1959 Dr. Frank Princi from the University of Cincinnati was the Chairman of a committee appointed by the Air Force Scientific Advisory Board to investigate the Air Force Toxicological Program. This committee found division of responsibility and lack of coordination between major commands in the development and application of environmental control of health hazards associated with Air Force weapons systems.

Insufficient effort was being made to obtain environmental health data from the civilian contractors of the weapon system. Also insufficient effort was being made to obtain and use environmental health data from Weapon Systems test programs at Cape Canaveral, Edwards and Vandenberg Air Force Bases.

The Toxic Hazards Section of the Aeromed Laboratory was attempting to develop toxicological data on the more promising military chemicals but in-house facilities were very limited and dollars for contract work was insufficient to keep abreast of the problem.

The Medical Laboratory of the Chemical Corps at Army Chemical Center had a Military Chemicals Program into which the 3 services were putting money for specific toxicological projects. Up to this time money for the Chemical Warfare Program had been severely limited and the laboratory was eager to get the business provided by the Military Chemical Program.

In early 1960 the Department of Defense decided to unify the 3 services toxicology programs and made the Medical Laboratory at ACC responsible for either performing in-house or letting and monitoring contracts for all toxicological investigations. Funding for this program was to be from DOD. This was the birth of Project Tores. The DOD Tores directive was so all inclusive that the role of the Toxic Hazards Section of the Aeromed Laboratory for a while was in doubt. However, later interpretations of the directive limited the work to be done under Project Tores as only that toxicology which was of interest to all 3 services. Project Tores was short lived. Its demise was initiated in early 1962 when DOD requested the Army to take over management responsibility for the project. For several reasons the Army was reluctant to accept the responsibility. The reasons included (1) the Army Chemical Corps had received a whopping large appropriation

for a BW/CW program and the Medical Laboratory of the Chemical Corps could no longer spare manpower or facilities for Project Tores; (2) Most of the dollar requirements for Project Tores were for Air Force requested work.

The Air Force advised both DOD and the Army that if it was DOD's desire to continue Project Tores the Air Force would accept management responsibility. However, the Army recommended that Project Tores be discontinued and each service again assume responsibility for its own Toxicology Program. This position was accepted by DOD with the stipulation that the work initiated under Project Tores be completed using DOD Funds and that a tri-service committee including Dr. Harry Hayes, Director of the Advisory Center on Toxicology of the NRC, monitor the work of the services to prevent duplication and to facilitate dissemination of information developed by the individual services. It is interesting to note that all of the work initiated by Project Tores is now being monitored by the Air Force. This is at the request of the Army and the Navy who recognized that the work was of primary interest to the Air Force.

Following Dr. Princi's study of the Air Force Toxicology Program another significant event occurred with which you are all familiar - which had an important effect on the Environmental Health Program of the Air Force - the reorganization of AMC and ARDC into AFLC and AFSC. Pertinent to Dr. Princi's criticism the development and application of environmental control of health hazards associated with weapon systems became the responsibility of just one command rather than being split between two as before. This command was AFSC. It was recognized that reorganization within AFSC and greater efforts to utilize the environmental health talents of AFLC would be required to successfully meet these new responsibilities. Considerable efforts have been devoted to insure that all possible environmental health data is obtained from civilian contractors of weapons systems and from weapon system test programs at Cape Canaveral, Edwards and Vandenberg Air Force Bases. A continuing effort has been directed toward using this data to develop adequate medical and environmental controls of potential health hazards associated with Air Force weapon systems.

A number of examples come to mind of steps taken or to be taken: (1) Requirements are now routinely written into contracts with weapon systems contractors to provide environmental health data which they have developed; (2) The Medical Service Staff within AFSC has and will further be beefed-up with knowledgeable physicians and sanitary and industrial hygiene engineers; (3) The Regional Environmental Health Laboratories are ever more performing environmental hazard evaluations at weapon systems test sites. The staffs of these laboratories are being augmented to meet the increasing demands for their services; (4) The budget of the Toxic Hazards Section of the Aerospace Medical Laboratory is continually being expanded.

Lastly and possibly most significant are the efforts being taken to use and disseminate the Environment Health data being accumulated. The recent AFSC publication of the Medical Aspects of Titan II is solid progress in this direction.

As is the formation of the Inter-Command Coordinating Committee on Missile and Space Medical Support items and the publication of the Toxicology News Letter by Headquarters AFSC, the Annual Sanitary and Industrial Hygiene Symposium provides an ideal means of communicating the latest information on environmental health data being developed within the Air Force. The need for this forum is well recognized and will perpetuate future successful meeting of the group.

ROLE OF THE TOXIC HAZARDS SECTION IN THE AEROSPACE MEDICAL PROGRAM

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6570th Aerospace Medical Research Laboratories
Wright-Patterson Air Force Base, Ohio

Toxicology, a former stepchild of pharmacology, is rapidly becoming a scientific discipline in its own rights. Encouraged by the recently formed Society of Toxicology, universities are setting-up educational standards to train people in this specialty. Thus, the importance of toxicology and the necessity of toxicological research, directly applied to the protection of people in todays' complex chemical environment, are well recognized. It is obvious that the Air Force, confronted with the challenge of technology in the space age, has an acute interest in toxicological reserach. Advanced Air Force operations will subject personnel to hazardous environmental conditions by the presence of new chemicals in the atmosphere, on the ground, in aircrafts, and in space vehicles. Man, and the integrity of his performance is, and will remain, an equally crucial link in the daring exploration of the universe or the most modern, push-button warfare carried out on this planet, in space or on the moon.

Although toxicology is becoming a science of its own, it is not a science for sciences'-sake only. It has a great impact on occupational medicine and industrial hygiene and this is the kind of toxicology research we are interested in the Air Force. The ultimate goal is the protection of the health of people who are probing the thresholds of the unknown. We do not, and probably never will, have enough of these people. Precious as these lives are, we should not be blinded by our eager desire to protect them at any cost since complete protection is impossible in the work which they do. Research and development deals with unpredictable quantities and qualities and, is risky, by its very nature. The researcher knows this and protects himself, to the best of his ability, by applying his previous experience and knowledge to new situations. In other words, he is not blindly running into his destiny but recognizes and carefully weighs the probabilities of outcome, and then, he takes a calculated risk. It still happens, that an experiment blows-up in his face.

Just as the physicist, the chemist, or for that matter an experimental pilot or astronaut is relying on certain "ground rules" to calculate his risks, and accept them as reasonable, the toxicologist dealing with new chemical materials is often forced to use his previous experience and sound scientific judgment to calculate the risks of toxic hazards in certain situations. His expert opinion will be the basis for medical and military decisions as to whether or not the risk is reasonable and justifiable and to go ahead with an important project. Consequently, a miscalculated

toxicological decision can result in either under or over protection of personnel and, in both cases, it can be translated in lost time and unnecessary expenditure of money. On the other hand, the right decision at the right time means time and money saved to improve the system. This is the only valid justification for toxicology research in the Air Force. Anyone who is familiar with the hectic milestone schedules of modern system development will appreciate this. Consequently, toxicology is here to help, not to hinder, missile and space technology.

What, then, are the basic requirements that will allow us to make the right decisions at the proper time? They are two-fold: fundamental and applied research, to give us the knowledge we need in the toxicology of new materials and the toxicology of new use of old materials. Within the Aerospace Medical Division, the Experimental Toxicology Branch of the School of Aerospace Medicine is engaged in fundamental research; the Toxic Hazards Section of the 6570th Aerospace Medical Research Laboratories is performing a strongly system oriented, applied research. This latter program is the subject of this presentation.

Work is carried out under AF Project 6302, Toxic Hazards of Propellants and Materials, and as its title implies, it is primarily engaged in the support of new missile and space systems.

The Project has the following objectives:

(1) To conduct animal and human studies to determine the extent and magnitude of toxic hazards of materials used by or generated in advance missile and space systems, high performance and experimental aircraft, and any other new chemical materials used in connection with R&D activities.

(2) To determine the optiumum method of measuring exposure levels and to establish acute, subacute, and chronic human tolerance criteria for the toxic materials encountered.

(3) To provide diagnostic criteria and to develop therapeutic procedures for exposure to these toxic substances.

(4) To develop criteria for protective procedures to determine the adequacy of decontamination and disposal techniques, and to evaluate their medical aspects in order to safeguard the health of Air Force and other R&D personnel exposed to toxic materials.

(5) To investigate and develop detection instrumentation, warning devices and personnel dosimeters which are necessary for the determination of toxic hazards and to evaluate the adequacy of detection and alarm systems for the protection of personnel from toxic hazards.

What are the mechanics of accomplishing this research? Since it is vitally important that toxicological research under this project be flexible and respondent to the needs of the Air Force occupational medicine program, especially in the areas of storable and high energy exotic propellants and fuels, early input is maintained by guidance from medical service specialists assigned to BSD and SSD. The emphasis is on system aspects of toxic materials. Consequently, continuous and close coordination with the System Project Offices and Project Engineers in the propellant development area is maintained.

(a) Tolerance levels to toxic chemicals are established by animal experimentation and, if necessary, verified by careful human volunteer exposures with specific emphasis on operating circumstances and system characteristics such as short-term, high level exposures and long-term, continuous, low level exposures.

(b) When indicated, site and mechanism of toxic action are investigated to facilitate the development of diagnostic and therapeutic methods.

(c) Evaluation of handling problems serves to establish industrial hygiene and occupational medicine policies by the appropriate Medical Service personnel. Project personnel and delegated Air Force agencies gather on-site information concerning the manufacture, handling, and test firing of new propellants. Additional data are acquired through liaison with medical directors, plant physicians, industrial hygienists, and safety personnel at Air Force and contractor installations. Clinical studies of fuel handlers are conducted where necessary. This medical intelligence provides the necessary criteria for the establishment of a well balanced in-house and contractual applied research program.

(d) Based on this medical information the appropriate analytical and detection instrumentation and warning devices are selected or developed so that the degree of required protection can be established. Special emphasis is placed on the environmental pollution potential with respect to R&D phases, extrapolation to operational usage, and accidental spills of propellant materials.

(e) Timely evaluation of toxic potentials and industrial hygiene requirements of new systems are conducted to give early indication of critically deficient areas of knowledge in toxicology, and to provide guidance for long range programming of a useful sustained effort.

Administratively, the Project consists of six Tasks: Toxicology, Pharmacology and Biochemistry, Identification of Toxic Materials (Detection), Environmental Pollution, Toxic Hazards Evaluation and

Toxicological Support. These tasks are under the direction of fully qualified research scientists at the Ph.D., M.D., and D.V.M. levels. The following list is a breakout of personnel of the Toxic Hazards Section according to specialty:

Manpower on Project 6302

1 MD	- Toxicologist (Chief)	GS-14
1 MD	- Pathologist	Capt
1 DVM	- Vet. Pathologist	Maj
1 PhD	- Pharmacologist	GS-13
1 PhD	- Chemist	GS-14
1 MS	- Industrial Hygienist	GS-13
2 Med.	Technologist	GS-9, GS-7
1 Med.	Lab. Technician	T/Sgt
1 BS	- Physicist	A/3C
1 Histology	Technician	A/3C
1 Clerk-Steno		GS-4
Total 12		7 Civ + 5 Mil

The following facilities are available for in-house research and are illustrated in the Appendix:

Facilities

Bldg 79, Area "B", WPAFB, Ohio

Floor Space - Sq. Ft.	
1,000	Detection and Chemical Laboratory
320	Instrumentation Laboratory
320	Pharmacol. Laboratory
320	Biochemical Laboratory
250	Ultra-Micro Clinical Chemical Laboratory
320	Histopath. Laboratory
320	Morgue - Necropsy
320	Pathology
300	Parenteral - Cutaneous Toxicology Laboratory
540	Inhalation Tox. Chamber (8) Room
640	Small Animal Holding Area
280	Cage Washing - Sterilizing Room
50	Dark Room
320	Conference Room
1,770	Office Space
3,930	Utilities
Total 11,000	Sq. Ft.

Field Capability: USAF Medical Research Propellant Support Unit

To fully utilize the research potential of these facilities, AF personnel will be augmented by contractor help at the Section to achieve a quick response inhalation capability and eight Rochester type exposure chambers will be installed for the study of propellant and space cabin materials.

The planned workload for a 2 year period is illustrated in the following table:

Projected Workload

Experimental Animals: Rats, dogs and monkeys.
Capacity of Each Chamber: 40 rats, 8 beagles, 4 monkeys
Phasing: First bank of 4 chambers for propellant work in mid 1963
Second bank for space cabin contaminant work in early 1964
Types of Inhalation Studies Required:

Propellants: rangefinding		Space Cabin:
single 4 hr. LD_{50}	chronic, 6 months	90 day contin.
subacute, 2 weeks	5, 15, 30, 60 min. ETL-s	
subacute, 6 weeks		

Requirements for Next 24 Months (from May 1963 to May 1965)

Test Runs	Animal Requirements		
	RATS	DOGS	MONKEYS
30 Rangefindings	6000	---	----
20 LD_{50}-s	2000	160	----
16 2-week subacute	3200	192	----
8 6-week subacute	1600	96	----
4 6-month chronic	800	48	----
2 Emergency Tolerance limits	1600	160	----
20 90 day continuous	1200	200	120
	16400	886	120

The foregoing demonstration of the scientific talent, laboratory facilities and broad coverage of toxicological research areas were used as an illustration to the Air Force in-house capability in applied toxicology research. They were presented with considerable scientific pride, since they represent a capability second to none, dedicated to the sole purpose of developing toxicological support to the Aerospace Medicine program.

This in-house capability is further augmented by a contractual research program all over the United States, amounting to approximately 50 man-years by competent and highly qualified investigators. Clearly, the Air Force is not only developing a new technology, but has the foresight to control its side-effects.

What is the pay-off of all this effort? It is not hardware, but the next best thing to it: Knowledge. This new knowledge is translated into design criteria and parameters for the production of hardware that is compatible with the man who has to put it to use in exploring the new frontiers of space, technology and national security.

SUMMARY OF EXPERIENCE IN DIRECT MEASURING INSTRUMENTS FOR MISSILE PROPELLANTS

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INTRODUCTION

Unsymmetrical dimethylhydrazine, hydrazine and NO_2 are used as propellants in the Titan II ballistic missile system. These propellants are potentially toxic, and detection instrumentation operating on a continuous or intermittent basis is needed for the industrial hygiene monitoring of these contaminants in air.

In the period of 1960-61, at the request of the SPO, commercially available instrumentation for UDMH and NO_2 was evaluated. Since that time some instruments have been improved and are available with a wider range. Results are reported as of the time of testing.

METHODS

Known concentrations of UDMH and NO_2 were produced using a metering-syringe, dynamic flow, dilution system (figure 1). This method of producing low level concentrations of volatile liquids and gases was developed by Dr. Robert Austin. A standard 100 ml hypodermic syringe was modified by fitting the plunger of the syringe with a finned cylinder of polystyrene so that when the syringe was mounted in a vertical position, the plunger could be made to rotate inside the barrel by directing an air stream at right angles to the polystyrene fin. A glass capillary was fitted to the end of the barrel and the flow from the syringe was adjusted by controlling the length and diameter of this capillary. The weight of the rotating plunger then forces the cylinder contents out through the capillary. Calculated amounts of the toxic agent were placed inside the syringe and the contents diluted with dry air to the 100 ml mark and mixed. Some adsorption takes place on the syringe walls during the first two fillings, and equilibrium is achieved by the third filling. The resulting gas mixtures were then metered into the instrument sampling line. Different concentrations were produced by varying the amount of toxic agent placed in the syringe. Volume-volume dilutions of UDMH in benzene were prepared and suitable aliquots of these solutions were completely vaporized inside the syringe. The gaseous $N_2O_4 \rightleftharpoons 2NO_2$ was transferred to the metering-syringe using other hypodermic syringes of appropriate sizes. The system was allowed to reach equilibrium for each concentration prior to sampling. Accuracy of the generated concentrations of UDMH and NO_2 was established using analytical colormetric procedures (Ref. 1, 2).

CALCULATIONS FOR SYRINGE METERING DEVICE

To calculate the amount of propellant to be added to the 100 ml. syringe the following information is incorporated in the calculations:

1. The critical orifice capillary delivers the contaminant gas at a constant uniform rate (ml/min).

2. The instrument air flow is constant (liters/min).

3. The total ml volume of the syringe used and the critical orifice size determine the total time of delivery (min).

4. Therefore, the total volume of instrument air during the syringe delivery time can be calculated by the formula:

$$V = R\,\frac{v}{r} \qquad (1)$$

where: r = critical orifice delivery rate (3.33 ml/min)
R = instrument air flow (20 liters/min)
v = total volume of delivery syringe (100 ml)
V = total volume of instrument air flow during delivery of the total syringe volume (liters)

By substituting in the formula:

$$V = 20 \times \frac{100}{3.33}$$
$$V = 600.6 \text{ liters}$$

5. The total quantity of liquid propellant to be vaporized in the syringe to produce x ppm of the propellant in the instrument flow is calculated as follows:

$$ml = V\,\frac{\frac{ppm \times MW}{24450}}{Sp\ gr \times 1000} \qquad (2)$$

(at 25°C and 760 mm Hg)

6. In calculating the amount of $N_2O_4 \rightleftarrows 2NO_2$ to be added to the syringe to produce a calibrating mixture, the volume expansion which occurs with air dilution must be taken into account. The relative amounts of NO_2 and N_2O_4 which exist at various pressures have been calculated from equilibrium data and are summarized in Table I. At 1.0 atmosphere pressure the undiluted equilibrium mixture is 31.2% NO_2 while after dilution with air the equilibrium at 1000 ppm is 99.3% NO_2.

At 25° C and 1 atmosphere the expansion factor is 1.7 and the amount of tank gas which must be used to obtain 50 ppm under the flow conditions described under formula 1 above would simply be:

$$50 : 1,000,000 = \frac{X}{1.7} : 600,600$$

$$X = 51 \text{ ml.}$$

This 51 ml of tank gas is put in the syringe and diluted to the 100 ml mark with dry air. This procedure is repeated 3 times to assure equilibrium conditions.

RESULTS AND CONCLUSION

The average percentage of error in generating UDMH and NO_2 were + 4.8% and ± 5.6% respectively. Results of testing are detailed in Table 2 and individual detectors are discussed in Tables 3-12.

Until further field data at missile sites become available, the requirements for sensing equipment must be arbitrarily established. Our interpretation of requirements for an "ideal sensor" for industrial hygiene field use includes the following:

1. Response time, 90% of full response in less than 1 minute.
2. Recovery time, 90% of full recovery in less than 1 minute.
3. Sensitivity, ± 50% of Threshold Limit Value (or better).
4. Baseline Stability, ± 25% of the Threshold Limit Value (in one hour).
5. Range 0-200 ppm (with range switch).
6. Cross-sensitivity, not responsive to ordinary atmospheric contaminants.
7. Weight - 20 lbs or less.
8. Polyethylene tubing and polyethylene parts wherever possible for NO_2 and UDMH.
9. Application to other propellant systems is very desirable.

TABLE I

Relative Amounts of NO_2 and N_2O_4 at Various Pressures

**Oxides of Nitrogen

*Pressure (Atmospheres)	% NO_2	% N_2O_4
.00025	99.7	.3
.001	99.3	.7
.01	93.8	6.2
.1	67.7	32.3
.2	55.9	44.1
.5	40.9	59.1
1.0	31.2	68.8
1.5	26.3	73.7
2.0	23.3	76.7

* Total Pressure $NO_2 + N_2O_4$

** The values listed are the relative amounts of NO_2 and N_2O_4

Above results are calculated from equilibrium data:

S. Glasstone, Textbook of Physical Chemistry, D. Van Nostrand Company, 1940.

TABLE II

COMPARATIVE EVALUATION OF DETECTION INSTRUMENTATION FOR UDMH AND NO_2

Name of Instrument	Baseline Stability	Range in ppm	Sensitivity in ppm	Type of Response	90% Response in Sec.	Cross Sensitivity	90% Recovery in Sec.	Specificity	Readout and Alarm	Wet or Dry System	Mil. Spec.
I for UDMH											
MSA Borane Analyzer	A	0-1.5 0-16	0.2 1.5	NL	NA	NA	NA	NA	DIG &	Wet	No
MSA Billionaire	A	0-8	0.3	LOG	7-10	NH_3 SM	8-19	A	R	Dry	No
American Systems, Inc.	A	0-5- 0-200	1 5	LIN	15-30	SM	10-35	A	Centr	Wet	No
Beckman Hydrocarbon	A	0-20 0-6000	0.5 150	NL	5-30	HC	5-30	NA	R	Dry	No
GE Shipboard Vapor Detector	A	0-5 0-100**	0.1 1.0**	LOG	10-15	-	10-15	A	Centr & Alarm	W/D	Yes
II For NO_2											
MSA Billionaire	A	0-10 0-80	0.5 6	LOG	7-11	SM	8-12	A	R	Dry	No
American Systems, Inc	A	0-250	5	LIN	25-40	SM	30-40	A	Centr	Wet	No

COMPARATIVE EVALAUTION OF DETECTION INSTRUMENTATION FOR UDMH AND NO_2 (Cont'd)

Beckman NO_2 Detector***	NA	0-200	5	LIN	35-50	SM	30-50	A	R	Dry	No
GE Vapor Detector	A	0-100**	10**	LOG	10	-	10	A	Centr & Alarm	W/D	Yes
Mast Co. Ozone Recorder	NA	0-25	2	LIN		SM		A	R	Wet	Yes
E24R Alarm	NA	0-20	5	LIN	60	NA	180	NA	M+Alarm	Wet	Yes

ABBREVIATIONS:

A = Acceptable
NA = Not Acceptable
LIN = Linear
NL = Non-Linear
LOG = Logarithmic
SM = Smoke
NH_3 = Ammonia
HC = Hydrocarbons
DIG - Digital Recorder
R = Recorder
M = Meter
Centr = Central Readout
W/D = Combined Wet and Dry

**Manufacturer's Claim - not tested here
***Breadboard

TABLE III

MINE SAFETY APPLIANCE COMPANY'S BORANE ANALYZER

for (UDMH)

Performance

	Low Range	High Range
Baseline stability	acceptable	acceptable
Range	0-1.5 ppm	0-16 ppm
Sensitivity	0.2 ppm	1.5ppm
Type of Response	non-linear	non-linear
Response time (90%)	10-15 minutes	20-30 minutes
Recovery time (90%)	10-15 minutes	20-30 minutes
Interference tests	not performed	not performed

Comments

1) The response and recovery times of this instrument are such that its practical use for monitoring UDMH is not recommended.

TABLE IV

MINE SAFETY APPLIANCES COMPANY'S BILLIONAIRE for (UDMH)

Performance

Baseline stability	acceptable
Range	0-8 ppm
Sensitivity	0.3 ppm
Type of response	logarithmic
Response time (90%)	7.5-10.5 sec.
Recovery time (90%)	8-19 sec.

Interference tests:

Materials	Response
Aerozine	positive
Hydrazine	positive *
NO_2	negative
Pentaborane	negative
Ammonia	positive*
Pump oil	negative
JP-4 (kerosene)	negative
Cigarette smoke	positive**
water vapor	negative

* response to hydrazine and ammonia was estimated by the MSA representatives to be ten times that of UDMH.

** cigarette smoke gave a positive response when a lighted cigarette was held close to the sample inlet of the instrument due to particles of appropriate size issuing forth directly from the cigarette.

Comments

1) The estimated price of this unit (without pump or recorder) was $2500. The detection system and associated electronics can be packaged in Hoffman boxes (same as those used by Western Dynamics and American Systems) and would weigh between 100 and 200 pounds. Power consumption with thermostatically controlled heating elements would be approximately 600-1000 watts. Output for the digital read-out would be 5-10 millivolts per ppm of contaminant.

TABLE V

AMERICAN SYSTEMS, INC'S AUSTIN TOXIC FUEL SENSOR, MODEL No. 4070

Performance

	Low Range*	High Range*
Baseline stability	acceptable	acceptable
Range	0-50 ppm	0-200 ppm
Sensitivity	1 ppm	5 ppm
Type of response	linear	linear
Response time (90%)	10-30 sec.	10-30 sec.
Recovery time (90%)	10-20 sec.	10-20 sec.
Interference tests:		

Material	Response
NO_2	negative **
B_5H_9	positive
NH_3	negative
pump oil	negative
JP-4 (kerosene)	negative
cigarette smoke	positive***

*These ranges were chosen arbitrarily so as to determine most accurately the performance characteristics of the sensors and to provide compatible useful range characteristics for the recorder. These are not fixed ranges incorporated by the manufacturer.

**NO_2 gave a negative response (one recorder division below zero on the LOW range) at a concentration of 2000 ppm.

***Cigarette smoke gave a positive response (about 5 ppm on the LOW range) when blown directly into the inlet.

Comments

1) This sensor is a production model of the prototype previously submitted by Micro-path, Inc. It's useful range has been increased to 200 ppm.

2) The instrument was submitted without any recorder or readout panel, since this particular unit was intended for central read-out application. For this technical evaluation the signal from the sensor was fed through an appropriate resistance dividing network to a 10 millivolt Brown recorder.

3) Problems previously associated with the pump used with this detector appear to have been alleviated. The instrument was operated continuously for a period of 2 weeks and no significant change was noted in the pump flow rate.

TABLE V (Cont'd)

4) The estimated price of the Fuel Sensor was $1200. This price is exclusive of any recorder or read-out system. Dimensions are 20" x 16" x 7.5", weight is 60 pounds, and power consumption is 150 watts at 115 volts and 60 cycles.

TABLE VI

BECKMAN INSTRUMENT COMPANY'S HYDROCARBON ANALYZER for (UDMH)

Performance

Baseline stability	acceptable
Range	0-20 ppm
Sensitivity	0.5 ppm
Type of response	linear
Response time (90%)	0.1-0.5 minutes
Recovery time (90%)	0.1-0.5 minutes
Interference tests	not performed

Comments

1) The instrument is equipped with a very sensitive ammeter in series with several scaling resistors (scale reading lx, 3x, xl0, x30, xl00, x300, xl000, and x3000). The meter has a linear scale marked from 0-100 and should be calibrated for the hydrocarbon of interest. A zero-adjust control allows one to zero this instrument to any constant background level of contamination, this zero, once set, is maintained through all positions of the attenuator control.

2) Higher concentrations (to 1000 ppm) than those used in the calibration were sampled by the instrument and the attenuator factors verified. In all cases the proper proportional reading on the meter was obtained when the attenuator was repositioned.

3) This instrument is not specific for UDMH but responds to UDMH because of the 2 methyl groups in the structure. It also responds to any vapor containing C-H bonds. Therefore, it is felt that if a significant number of interfering hydrocarbon substances (even at low concentration) are likely to be present, the validity of readings in terms of actual UDMH concentration would be questionable.

TABLE VII

GENERAL ELECTRIC COMPANY'S VAPOR DETECTOR for (UDMH)

Performance

Baseline stability	acceptable
Range	0-5 ppm
Sensitivity	0.1 ppm
Type of response	logarithmic
Response time (90%)	10-15 sec.
Recovery time (90%)	10-15 sec.
Interference tests	not performed

Comments

1) Concern over the limited range was partially alleviated upon receiving a report from General Electric subsequent to our tests showing results of double dilution technics in an effort to extend the range of the instrument. Results indicate that the dilution technic is practical and that a scale may be chosen that best meets the application requirements.

2) Due to the very high volume air flow (approximately 30 liter/min) contamination as far as 20-30 feet away from the sampling point was detected by this instrument. This feature would reduce the number of point source instruments required at any particular installation.

3) The instrument has been subjected to rigorous shock and vibration tests and conforms to the Navy Military specifications.

TABLE VIII

MINE SAFETY APPLIANCES COMPANY'S BILLIONAIRE for (NO_2)

Performance

	Low range	High range
Baseline stability	acceptable	acceptable
Range	0-10 ppm	0-80 ppm
Sensitivity	0.5 ppm	6 ppm
Type of response	logarithmic	logarithmic
Response time (90%)	8-11 sec.	7-11 sec.
Recovery time (90%)	8.5-12.5 sec.	10-11.5 sec.
Interference tests:		
	Material	Response
	Aerozine	negative
	UDMH	negative
	Hydrazine	negative
	Pentaborane	negative
	Ammonia	negative
	Pump oil	negative
	JP-4 (kerosene)	negative
	Cigarette smoke	positive*
	Water vapor	negative

* Cigarette smoke gave a positive response when a lighted cigarette was held close to the sample inlet of the instrument due to particles of appropriate size issuing forth directly from the cigarette.

1) The estimated price of this unit (without pump or recorder) was $2500. The detection system and associated electronics can be packaged in Hoffman boxes (same as those used by Western Dynamics and American Systems) and would weigh between 100 and 200 pounds. Power consumption with thermostatically controlled heating element would be approximately 600-1000 watts. Output for digital readout would be 5-10 millivolts per ppm contaminant.

TABLE IX

AMERICAN SYSTEM, INC'S AUSTIN OXIDIZER SENSOR, MODEL 4075 for (NO_2)

Performance

Baseline stability	acceptable
Range*	0-500 ppm
Sensitivity	5 ppm
Type of response	linear
Response time (90%)	5 seconds
Recovery time (90%)	5 seconds

Interference tests:

Material	Response
UDMH	Neg
hydrazine	Neg
pentaborane	Neg
ammonia	Neg
pump oil	Neg
JP-4 (kerosene)	Neg
cigarette smoke	Neg

*This range was chosen arbitrarily so as to determine most accurately the performance characteristics of the sensor and to provide compatible range characteristics for the Recorder. This is not a fixed range incorporated by the manufacturer.

Comments

1) This sensor is a production model of the prototype previously submitted by Micropath, Inc. The shortcomings of this instrument that rendered it unsuitable for long-term, unattended operation, have been overcome. The response and recovery times have been significantly decreased.

2) An attempt was made to find the maximum concentration that could be measured accurately by this sensor without overloading. This occurred at approximately 2000 ppm.

3) This instrument was submitted without any kind of recorder or read-out panel since this particular unit was intended for central read-out application. For this technical evaluation the signal from the instrument was fed through an appropriate resistance dividing network to a 10 millivolt brown recorder.

4) There was no lag time associated with initial low level concentrations; this appeared to be a problem with the prototype instruments previously evaluated. Problems associated with the pump used in this detector appear to have been alleviated. No noticeable corrosion of the metal fittings was experienced

TABLE IX (Cont'd)

during the period of evaluation.

5) The estimated price of the Oxidizer Sensor was $1000. This price is exclusive of any recorder or read-out system. The dimensions are 20" x 16" x 7-1/2" weight is 60 pounds, and power consumption is 150 watts, at 115 volts and 60 cycle.

TABLE X

BECKMAN INSTRUMENT'S FLOW COLORIMETER FOR NITROGEN DIOXIDE

Performance

Baseline stability	acceptable
Range	0-200 ppm
Sensitivity	5 ppm
Type of Response	linear
Response time (90%)	35-50 sec
Recovery time (90%)	30-50 sec

Interference tests:

Material	Response
Aerozine	negative
pentaborane	negative
ammonia	negative
pump oil	negative
JP-4 (kerosene)	negative
water vapor	negative
cigarette smoke	positive

Comments

1) The instrument submitted for this evaluation was a "breadboard" or prototype model; the manufacturer stated that the unstable baseline would be eliminated in any production model purchased by the Air Force.

2) The principle of operation of this instrument is that of a colorimeter and the color of NO_2 is measured at its peak absorbancy. Only colored gases and vapors having similar absorbancies would be expected to give interfering responses. Of course, smokes (such as that from a cigarette) and fogs will give interfering responses since they will physically block the light beam of the measuring cell and consequently will reduce the amount of light reaching the phototube.

3) The estimated price of each unit was $3200 (in quantities over 100, $3000). Weight was estimated at 100 pounds each. The dimensions of the final production model were estimated to be 4' x 2' x 1.5'. No power consumption figures were given; however, it is estimated that a thermostatically controlled unit would consume approximately 500-1000 watts.

TABLE XI

GENERAL ELECTRIC COMPANY'S TOXIC VAPOR DETECTOR* for (NO_2)

Performance

Baseline stability	not reported
Range	0-100 ppm
Sensitivity	5 ppm
Type of response	logarithmic
Response time (90%)	not reported
Recovery time (90%)	not reported
Interference tests	not reported

*This instrument was not evaluated by this Laboratory. The data presented was submitted by the manufacturer.

TABLE XII

MAST DEVELOPMENT COMPANY'S OZONE METER for (NO_2)

Performance

Baseline stability	not acceptable
Range	0-25 ppm
Sensitivity	2 ppm
Type of response	linear
Response time	not recorded
Recovery time	not recorded
Interference tests	not performed

Comments

1) Except for the lwo lowest concentrations monitored, readings were off-scale with the range switch of the recorder on LOW. Therefore, all readings were taken with the range switch on HIGH.

2) Modifications should be made on the air sample flow control valve so that a more uniform air flow can be achieved. Without this modification this instrument cannot be left unattended for any extended period of time.

TABLE XIII

E-24 R ALARM for (NO_2)

Performance

Baseline stability	not acceptable
Range	0-25 ppm
Sensitivity	2 ppm
Type of response	non-linear
Response time (90%)	30 sec.
Recovery time (90%)	30 sec.
Interference tests	not performed

Comments

1) The principle involved in the operation of this detector is that of a conductivity cell. It is therefore considered to lack specificity, thereby rendering it unacceptable for use in detecting specific water soluble vapors.

REFERENCES

1. Pinkerton, M. C., Lauer, J. M., Diamond P., Thomas, A. A., A Colorimetric Determination for 1,1 Dimethylhydrazine in Air, Water, and Blood. ASD Technical Report 61-708, Wright-Patterson Air Force Base, Ohio, Dec. 61.

2. Saltzman, Bernard E., Colorimetric Microdetermination of Nitrogen Dioxide in the Atmosphere, Analytical Chemistry Vol. 26, 1949 (Dec. 54).

TOXIC HAZARDS OF NEW PROPELLANTS

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The problems associated with the handling of cryogenic propellants and the resulting slow-down of missile launchings, coupled with the need for higher specific impulses, long storability and instant readiness of missiles has resulted in a concentrated effort to develop suitable new propellants. This second generation of propellants, called the storables, is finding increased use in our new weapon systems. The first typical examples are the TITAN II and Minuteman ICBM's, the first being a liquid, the second a solid fuel missile.

Development of course, has not stopped with these prototypes, and a real structural roulette is in full swing throughout the propellant industry for better, high energy propellants. The result of this search is a new brand of chemistry, and hence the terminology of "exotic" compounds is well justified.

In the oxidizer field, basic theoretical trends are illustrated in Table 1. The synthesis of oxygenated, fluorinated, interhalogenated, oxyfluorinated, and other N-F, and N-O-F compounds, coupled with the drive to increase stability has resulted in thousands of new compounds, never encountered before by the toxicologist.

TABLE 1

Theoretical Trends in Storable High Energy Oxidizers

O - O Chemistry:	O_3, H_2O_2
N - O Chemistry:	HNO_3, N_2O_4
O - F Chemistry:	OF_2, O_3F_2
Interhalogens:	ClF_3, BrF_5
N - F Chemistry:	NF_3, N_2F_4

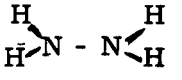
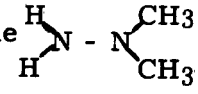
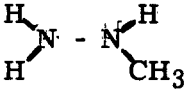
The fuels are equally represented by new variations on the recurring themes of hydrazine, boron, aluminum, beryllium, and hydrogen chemistry. In addition, stabilizers, plasticizers, curing agents, and other necessary additives are being sought with relatively high energy content to improve overall performance.

Many of these newly synthesized compounds are of theoretical interest only, and are not stable enough to be useful as propellants. Therefore, various radicals are added to prevent decomposition, shock sensitivity, and explosive properties. This structural manipulation is not a new phenomenon, and is well known from the other branches of chemical industry, especially the polymer and pharmaceutical endeavors. It is needless to say that minor changes in the basic structures can result in entirely different biological activity, and therefore a systematic toxicological screening program is becoming increasingly difficult, unless it is pursued with the same intensity as the development of new drugs and therapeutic agents.

Let us therefore turn our attention to those newer propellants, which have proven their value in small scale tests at least, and to those which are approaching operational use. Table 2 is a summary of such fuels and oxidizers.

TABLE 2

New High Energy Propellants in Use

Liquid Fuels		Solid Fuels
Hydrazine		Aluminum
1, 1 - dimethylhydrazine (UDMH)		Beryllium
Monomethylhydrazine (MMH)		
Aerozine - 50	(a 50-50 mixture of hydrazine and UDMH)	
Pentaborane	B_5H_9	
Decaborane	$B_{10}H_{14}$	

Liquid Oxidizers		Solid Oxidizers
Nitrogentetroxide	N_2O_4	Chlorine derivatives
Chlorinetrifluoride	ClF_3	Fluorine derivatives

Toxicity of these propellants is considerably higher than any of the cryogenics used before except liquid fluorine. For general guidance, the MMH is approximately twice as toxic as hydrazine, and UDMH is approximately half as toxic, on a mg/kg basis. The fallacy of this comparison becomes evident however, if one compares vapor pressures. To illustrate that toxicity and toxic hazards are two entirely different indexes, let us consider Aerozine-50. UDMH has a vapor pressure ten times higher than hydrazine, and although hydrazine is twice as toxic as UDMH it contributes no practical inhalation hazard to the TITAN II fuel. Hydrazine could become important as an inhalation hazard if the UDMH was already evaporated as could occur in an open spill situation. Naturally, the skin absorption hazard from hydrazine becomes negligible if protective clothing is worn during handling.

The boranes are much more potent than the hydrazines. Since it takes so little to cause serious intoxication, the marked differences in vapor pressures of pentaborane and decaborane affords no practical protection considering the 0.001 and 0.05 ppm suggested Threshold Limit Values (TLV). While it is true that pentaborane will evaporate much faster than decaborane, both can reach hazardous concentrations in air within a few minutes.

Another salient point in judging the toxic hazards of propellants is the amount of warning one can expect during inhalation exposure to high concentrations. Table 3 points out these differences.

TABLE 3

Warning Symptoms for High Concentrations

Hydrazines:	Strong Amine Odor	- respiratory irritation.
Fluorines:	Corrosive Fumes	- bronchospasm, respiratory and eye irritation.
$N_2O_4(2NO_2)$:	Acid Odor	- No immediate respiratory irritation.
Boranes:	Questionable, Faint Odor	- no immediate symptoms.

Practical human exposure experience has substantiated the observations in this table. While it is almost impossible to voluntarily tolerate acutely toxic concentrations of the hydrazines and fluorines, the unnoticed severe exposures of propellant handling personnel to NO_2 and boranes is a frequent occurrence.

While the above is true in acute exposures, none of these compounds possess adequate warning character in chronic exposures, that is, during production and pilot-plant operations. There, the compliance with TLV's and good industrial hygiene practices is of utmost importance.

Fortunately, the dose-response relation is very predictable with these propellants. Figure 1 illustrates the dose-time relations with UDMH, hydrogen fluoride, NO_2, and pentaborane. The steeper these slopes, the more predictable is the toxic effect (in this case, death) at any point on this graph. Also, because the toxic effects are more predictable, one can set tolerance limits with much more accuracy and validity. Consequently, one does not feel compelled to incorporate tremendous safety margins in these limits. While this is a marked advantage and can expedite significantly the handling of these propellants, there is a distinct danger in the misuse of these limits by laymen who do not realize the absence of the usual 10-fold safety margin.

To elaborate this point, Table 4 lists the criteria on which the well publicized Emergency Tolerance Limits to the TITAN II propellants were based:

TABLE 4

Acute Tolerance for Single Exposure (in ppm)

	Animal (Measured)				Human (Suggested)	
	"No Death" (Rats)		"No Pathology" (dogs)		"No Effect"	
	5 min	60 min	5 min	60 min	5 min	60 min
UDMH	19,800	813	600	50	50	10
NO_2	190	72	104	28	35	10
Pentaborane	62	7.5	-	-	-	-

Clearly, a ten-fold excess of the suggested 35 ppm tolerance for the specified 5 minute period to NO_2 could lead to severe pulmonary edema in any exposed person, and undoubtedly would result in death in some cases. By the same token, a 5 minute exposure to 500 ppm UDMH could become a most unpleasant experience, far from the level of no effect.

The probable source of such misconceptions is illustrated in Table 5. The day-by-day, 8-hour TLV's are set for the avoidance of chronic, repeated exposures, and entail a wide margin of safety.

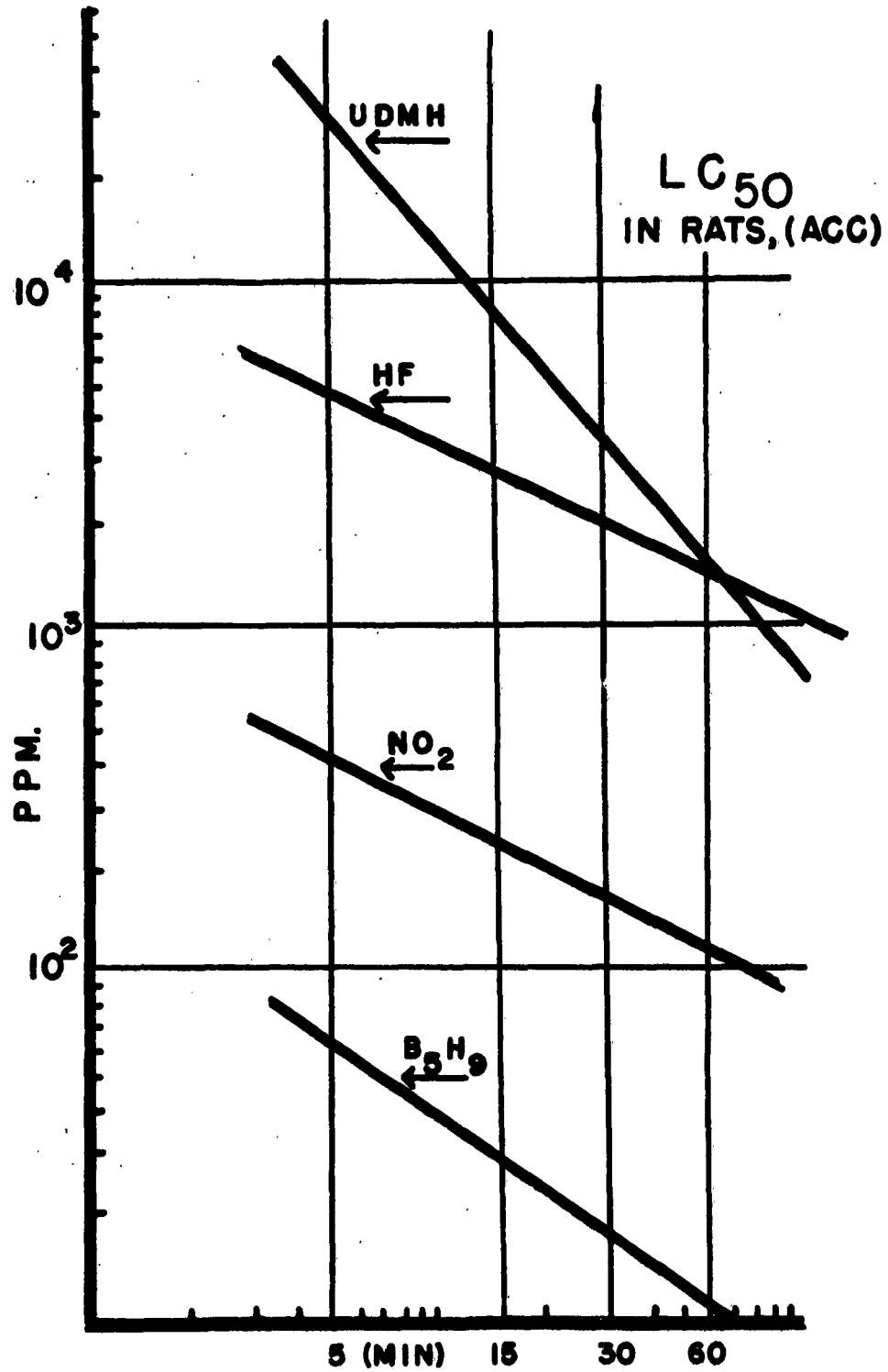

UDMH
HF
NO_2
B_5H_9
LC_{50}
IN RATS, (ACC)
10^4
10^3
10^2
PPM.
5 (MIN)
15
30
60

TABLE 5

Human Tolerance Limits for Inhalation (in ppm)

Propellant	TLV	Emergency Single Tolerance			
	(8-hr, repeated)	5 min	15 min	30 min	60 min
Nitrogen Tetroxide	5.0	35	25	20	10
Hydrazine	1.0				
UDMH	0.5	50	35	20	10
Pentaborane	0.005				

Needless to say, one can occasionally be exposed to 10 times the TLV of any of the propellants for a few minutes without serious consequences. A much greater danger of the misinterpretation of Emergency Tolerance Limits is the use of these criteria for the calculation of toxic exclusion distances as they affect the communities adjacent to missile bases. Beyond 10 miles or more, the theoretical prediction of toxic vapor concentrations can easily be in error by a factor of ten. An added consideration is that these limits were set for Air Force use and assume a healthy, relatively young adult population. On the other hand, civilian communities consist of both healthy and sick, young and old, some with severe asthmatic and cardiac conditions. Such people could not necessarily tolerate even the emergency levels.

To complete this discussions, let it suffice to say that the toxicological problems associated with solid propellants are less numerous. The more serious problems are usually related to either exhaust products or processing accidents. Basically, the toxicology of chlorine and fluorine derivatives is not new. There are, however, some intriguing problems on the toxicology of beryllium oxide and the epidemiology of chronic beryllium disease.

There are a number of important toxic hazard considerations with large scale propellant operations, but they fall beyond the scope of this presentation. The area of detection, diagnosis and therapy, environmental pollution, site selection, and toxic exclusion radii are discussed by the author in a recent issue of Industrial Medicine. The reader is referred to that publication for more detailed discussion of the problem.

MICROWAVE RADIATION AS A USAF ENVIRONMENTAL HEALTH HAZARD

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1. Microwaves - What Are They?

Microwaves originate as electromagnetic impulses in a high frequency oscillator tube. They are carried, via a waveguide, to a transmitting antenna which radiates them outward at the speed of light.

Microwaves occur in a band of the electromagnetic spectrum just above ordinary radio waves, from about 300 to 300,000 megacycles per second. The most common frequencies encountered in the AF lie between 390-1550 megacycles (L band) 1550-5200 mc (S band) and 5200-10,900 (X band).

2. Effects of Microwaves on the Body.

When microwave radiation is transmitted in space, its energy is either reflected or absorbed by interferring objects. The total amount absorbed is dependent on the nature of the material and on the frequency and power density, or flux of the radiation.

The absorbed energy produces localized heating of tissue in varying degrees. Through animal experimentation, it has been shown that short wave lengths cause maximum heating effects at the skin surfaces, while longer wave lengths produce heating of the deeper tissues and internal organs.

Microwave radiation at frequencies above 3000 mc and above is usually reflected or absorbed by outer skin layers and will give immediate warning as a result of superficial heating. Radiation occurring below 3000 mc is more serious, as the heating will occur in the fatty and deeper tissues of the body without adequate warning. Chronic injury may result from repeated low level exposures, if the heat cannot be readily dissipated.

Personnel in the AF and in civilian industry who are occupationally exposed to microwave radiation have been closely followed during the past ten years. The results of physical examinations show no significant evidence of temporary or permanent body injury as a result of such exposure.

3. Exposure Limits.

The maximum permissible limit for USAF occupational exposure has been established at 10 mw/cm^2, for all frequencies. No stipulation has

been made as to duration of exposure, such as an eight-hour period, due to lack of data correlating time, frequency and power density. It is interesting to note in a recent Russian technical report that limits as low as 0.01 mw/cm^2 have been recommended (for frequencies above 300 mc per second).

4. Use of the Ramcor Densiometer.

The Ramcor Densiometer (Models 1200 and 1250) is a portable battery operated instrument that will detect and measure VHF, UHF and microwave energy.

The scale is calibrated in decibels (db), plus or minus in reference to zero, or 10 mw/cm^2. For conversion to mw/cm^2, a chart is provided, or a simple rule of thumb may be used: +3 db indicates a doubling or halving of power density. Limits are 1-20 mw/cm^2.

The principle of operation is similar to that of the Wheatstone Bridge. A balance resistor varies the current through a thermistor, changing its resistance; when the thermistor resistance is equal to that of a reference resistor, no current flows through the meter.

When microwave energy is applied via the antenna, the thermister resistance will change, unbalancing the bridge; current flows through the meter indicating field strength.

In making measurement, the antenna is pointed toward the radiating source and oriented so that a maximum reading is obtained. Care must be used in locating the maximum reading as the antennae are very direction sensitive.

5. Survey Procedure.

Standardized survey procedures are not recommended due to varying conditions and types of units. However, the following information should be obtained for all units surveyed, whether ground or airborne radar.

a. Nomenclature, including type, peak and average power in watts, size and configuration of antenna, frequency(ies) used.

b. For search and other fixed ground units, maximum negative tilt of antenna, use of blankers, areas or buildings in direct path of beam with elevations, distances, and azimuths, and degree of occupancy in inhabited areas.

c. For mobile and airborne units, the average power levels used are so low that no hazard will exist under normal operating conditions. In

maintenance and repair operations, however, workers may be required to insert hands and arms into the near field of the antenna (within several inches of the feed horn). A check should be made immediately adjacent to the feed horn in order to determine the power density.

d. Are personnel exposed routinely, intermittently, or not at all?

e. Protection provided: warning signs, safety lectures, use of dummy loads and blankers, periodic physicals.

RADIATION PROBLEMS ON AN AIR FORCE BASE

Captain Carl J. Weinberg
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INTRODUCTION

1. The theme of the program this afternoon is "Radiation Problems on an Air Force Base," and was chosen to correspond to your requests. You may remember that I sent out a letter early this year asking for suggestions on what you would like to hear at a health physics symposium. The overwhelming majority asked for answers on what to look for in three broad topic areas:

a. What radioisotopes to look for on an Air Force Base.

b. How to conduct a radar unit survey.

c. How to conduct an x-ray protection survey.

2. I will start off with what isotopes to look for on a typical base. Captain Kendig from the Regional Environmental Health Laboratory at Kelly AFB will discuss the x-ray surveys, and Captain Kennebeck from the Regional Environmental Laboratory at McClellan AFB will discuss the radar survey. We have kept the presentations shorter than the the allotted time deliberately to allow questions. There will be a short question period at the end of each presentation and a general question period when all presentations have been completed. I want to re-emphasize the importance of asking questions. It is only in this way that we can discuss and help you with your specific problems.

3. We have deliberately steered away from some topics as they will be presented by other speakers. You will notice on your program that tomorrow morning is also heavy on the health physics aspects of your job. So, this afternoon, we will not discuss in detail the film badge program, exposure limits, aircraft contamination, or standard radiac instruments, as these subjects will be covered by the speakers tomorrow.

4. Since this is to be a symposium, I would like this afternoon at least to have the spirit of the symposium prevail in the old Greek tradition. In ancient Greece a symposium was a drinking together, usually following the banquet proper, with music, singing, and conversation; hence, a social gathering at which there is a free interchange of ideas. Lunch wasn't quite a banquet--and the music, singing, and drinking won't start until tonight, but I do hope that this afternoon will bring at least free interchange of ideas!

WHAT ISOTOPES TO LOOK FOR ON AN AIR FORCE BASE

1. One of the primary potentials for exposure on any Air Force base outside of the hospital is in the Precision Maintenance Equipment Laboratory (PME Laboratory). These laboratories are now authorized to calibrate all radiac instruments on any Air Force Base and to do this job they are provided with radioactive calibration sources. The present authorized Co-60 sources are being replaced by Cs-137 calibration sources. This replacement is now taking place. The new Cs-137 sources are described in TO. 11H4-8-5-1, Utilization and Maintenance of Cs-137 Test Samples. The sample contains about 100-120 mc of Cs-137, with a half-life of 26.6 years and emits gamma radiation of 0.66 mev. It has some beta emission but the source is doubly encapsulated and all beta emission is absorbed. In addition, the PME Laboratories are authorized a Plutonium-239 calibration test set for calibration of alpha measuring instruments.

2. Actually, these sources represent a good example of a typical hazard and I would like to use it to illustrate some of the requirements of a radiation protection program. Also, since these sources are licensed by the AEC, (that is the AEC authorized the USAF Radioisotope Committee to distribute and control the sources within the Air Force) their use must conform both to AEC and AF regulations. The basic requirement for the AEC are contained in 10CFR20, Standards for Protection Against Radiation (of which you have a copy), and for the Air Force in TO. 00-110N-3. If you read any documents, read these two. Actually, TO. 00-110N-3 has been revised to conform to 10CFR20 in most cases.

3. So let us take a "for instance." A PME Laboratory has just been organized on your base and is applying for calibration sources, CS-137 and Pu-239. In order to get the sources from SAAMA, you must have an Air Force Radioisotope Committee Permit. This permit has been revised only lately to a 1-page document. You get this permit by submitting the required information contained in TO. 00-110N-3. This information is to provide answers to essentially the following questions:

a. Who will handle the source and what is his training?

b. Where will it be used?

c. Who will act as radiation protection officer?

d. What instrumentation is available?

e. Are film badge services provided?

f. Are the people cognizant of applicable directives?

The application is then forwarded to the USAF Radioisotope Committee located in the Surgeon's Office, AFLC. This Committee reviews and approves the use of isotopes Air Force-wide and also acts as the official liaison with the AEC in regard to licensing of isotopes within the Air Force. As a guideline for training we require that the individual have as a minimum attended the PMEL Technician Course at Lowry AFB. This course contains about 60 hours of instruction on the calibration of instruments and handling of radioactive calibration sources. For the radiation protection officer, we require a minimum of training equivalent to the 2-week Basic Radiological Health Course that most of you have had. We would prefer that the Sanitary and Industrial Hygiene Engineer be appointed as Radiation Protection officer, but in some cases this cannot be done. The Committee then reviews the application and approves the Permit if all information is in order. Upon approval, SAAMA will ship the source to the base.

4. Now let us assume that you are going to make a survey on a PME laboratory or any other organization that is using isotopes. The first thing you should establish, besides what sources they have, is "are the sources under control of the individual user." In this respect the AEC defines a "restricted area" as any area to which access is controlled for purposes of radiation protection. In TO. 00-110N-3 it is called a "controlled area" in order not to create confusion with regard to "classified areas." What does this mean? Merely that no one but the designated individuals should be able to get at the isotopes. For the standard Pu-239 calibration sources, it could be merely a locked desk drawer; for the Cs-137 it means locking the source container and shield itself. It is preferable that this be in a locked closet or cabinet, but this is not an absolute requirement.

a. Each container or area that has in it licensed material must have a warning sign "Caution Radioactive Material." (Slide 1) This is irrespective of the radiation intensity. This is a standard Air Force form described in TO. 00-110N-3, and conforms with 10CFR20. If the container is used to store the isotope, it must also contain the name of the isotope, quantity, and data of measurement. So this sign identifies that radioactive material is present, but gives no information regarding the levels of radiation in the environment.

b. If the radiation intensity is greater than 2.5 mr/hr but less than 100 mr/hr, there must be a sign saying "Caution Radiation Area." (Slide 2) It is advisable to put this up where people will encounter the radiation field, either at the entrance to an area or at the 2.5 mr/hr level. This means that the sign must be put up whenever a source is to be removed from storage and used. In most PME laboratories there will be a line drawn on the floor indicating the radiation area that requires the sign. Check it. If you are on a base that does have industrial radiography, the same is true about placing your ropes and signs, so that any time there exists a radiation field of 2.5 to 100 mr/hr the "Caution Radiation Area" sign is displayed.

c. If the intensity should be above 100 mr/hr, then a sign saying "Caution High Radiation Area" (Slide 3) must be displayed. In addition, you must have some visual or audible signal if a person should enter the area. Both TO. 00-110N-3 and 10CFR20 specify the conditions required. The door to the room containing a Co-60 teletherapy unit, therefore, would have both a "Caution Radioactive Material" and "Radiation Area" sign.

d. If you should be using isotopes, such that the possibility exists of an airborne hazard, then the following sign should be posted: "Caution Airborne Radioactivity Area." (Slide 4) This means that concentration of activity exceeds the limits given in 10CFR20 or AFP 160-6-7, "Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and in Water for Occupational Exposure." In fact, if you are using isotopes which could become airborne, both the USAF Radioisotope Committee and the AEC will request information on airborne concentrations and this implies that you have an air sampling program. In other words, these signs were designed to tell people that radioactive material is present and then the type and degree of hazard.

6. You will also need to ask:

a. What is going to be done with the isotopes?

b. How will it be done?

c. What actions will be taken if something goes wrong?

For the standard Air Force items most of the answers are provided in applicable technical orders, but let us go through what the answers might be with regard to the Cs-137 source:

a. The source should be used only to calibrate radiac instruments. It should not be used for training monitoring teams.

b. A definite area should be laid out to perform the calibration. Proper signs should be available to delineate the radiation areas.

c. Watch them perform some calibrations. Are the instruments handled so that only the hands enter the main beam?

d. What SOP is available if the source should happen to fall out of the shield?

The answers to these types of questions are sometimes not so simple with other uses of isotopes. Industrial radiography, for instance, where the location varies from day to day and where there might be a problem returning the source to the shield. In these cases, it would be desirable to have

some written rules that must be followed. We are having many licenses returned by the AEC because the SOP's were not directed to the individual handling the isotopes and required looking at other documents in order to fully understand them. In other words, none of the typical SOP style -- "so and so will be done in accordance with paragraph 2b(4), Section S, AFM 160-23." This dosen't really tell the person what to do!!

7. Personnel monitoring is another aspect that must be considered. You will usually have to recommend a system. In most cases the film badges are sufficient. As a rule of thumb, I would say that any time you use a "Caution High Radiation Area" sign you might wish to supplement the film badge with a pocket dosimeter that can be read at the end of each working day. This might well be the case of our calibration laboratories that have AN/UDMA 100-curie Cs-137 source. I also want to point out that if you have an overexposure to isotopes, that is more than 1.25 rem/quarter, you must report it to the ACE. I suggest you pass the information on to the USAF Radioisotope Committee so that we can report it to the proper AEC Compliance Region. Neutron badges present a special problem and you should contact the USAF Radiological Health Laboratory. Please do not say you are using DT-60's. They were not designed to record levels below about 25 roentgen.

8. Finally, there is the requirement that if you have sealed sources you must check them at 6-month intervals to see that they are not leaking. This is primarily to make sure that the area does not become contaminated. The AEC also requires that the test be sensitive enough to detect 0.005 microcuries of activity. This means that you cannot perform a proper leak test utilizing only standard Air Force radiac equipment. The thin window of the PDR-27 will give you an indication when you approach 0.05 microcuries and a field test using the PDR-27 is described in TO. 11H4-8-5-1. In order to detect 0.005 microcuries, you will need a thin end window GM tube coupled to a scaler. The technical order is written so that you may mail the swab to the Regional Environmental Health Laboratories in the US, the 7112th Central Medical Group in Europe, and the 5th Epidemiological Flight in Japan. Each of these places has equipment sensitive enough to detect 0.005 microcuries. If you have the necessary equipment you may count the swab yourself. I think the easiest way for me to tell you what to do is to show you. (Slide 5)

This shows a Cs-137 source in its shipping container. The source is bolted to the bottom of the container so that when you lay the container on its side it also acts as a collimnator. You never remove the source -- you only remove the source plug. (Slide 6)

For the wipe we finally decided to use a pencil and a paper towel, primarily as these two items are available to every Air Force installation anywhere in

the world. You cut out a strip of paper towel, wet it, and wrap it around the pencil. If you wrap it tightly it will stick to the pencil without any additional means to hold it.

(Slide 7)

Then remove the source plug. This plug fits tightly around the source. Keep your face away from the beam hole. No use getting that irradiated. Move away from the source and monitor the plug with the PDR-27. You should get absolutely zero unless it is contaminated. If you get a reading, you would suspect a faulty instrument or that the plug is contaminated and then you would expect a positive leak test. Run the wet swab all around the hole on the bottom of the plug, then along the sides of the plug.

(Slide 8)

Replace the plug then monitor the swab with the instrument, holding it as close to the swab as possible. If you get any reading at all I would suspect that the source is leaking and not use it until the results have been returned from the laboratory. I would also check the instrument by slowly moving the swab close to the probe and then removing it. The needle should go up scale as you move closer to the probe and drop to zero as you move away. If it dosen't, be careful what conclusions you draw.

(Slides 9 and 10)

After you complete your field evaluation send the swab to your designated laboratory by wrapping it in paper, sealing the ends in with tape, or use aluminum foil or Saran wrap. Then put it in an envelope with the necessary information. Put the whole works in a mailing tube. Do not mix several swabs in the same envelope. The laboratories do get them that way!

9. Records. Now we come to the most overlooked portion of any program - records. The AEC is now inspecting our bases and has inspected quite a few PME laboratories, and records are what they are looking for, so don't think it can't happen to you. The inspection reports, if discrepancies are found, arrive by registered mail to the Commanding Officer with 24 hours to reply. So what records do you need?

a. Surveys. Has a competent person made a survey of the situation? By this, the Medical Service is usually implied; the sanitary and industrial hygiene engineer or health physicist, if available. And most important, is the survey on file and current?

b. Exposure records. Are records kept of the film badge results and are they up-to-date? Captain Markarian will mention something about this tomorrow.

c. Leak test. Are leak tests made at 6-month intervals and are the results recorded?

d. Disposal records. In most cases, disposal is made through TO. 00-110N-2, and you would have shipment instructions. In cases where you meter a liquid solution into the sewer, you have had a record of total amount disposed of by each day.

10. Now, let us apply some of these principles or requirements by looking around an Air Force Base.

a. PME Laboratory.

(1) Co-60 calibration source, TO. 11H4-8-3-1. This source is presently being removed from Air Force use and the same precautions apply as with the Cs-137 sources.

(2) Cs-137 calibration source, TO. 11H4-8-5-1.

(3) Pu-239 test sample, TO. 11H4-8-4-1.

(Slides 11 and 12)

(4) Cs-137. 100-curieAN/UDM-1A (Slides 13 and 14) This is a fairly large source requiring remote telescope reading.

b. On the aircraft.

(1) Tritium markers, exit signs, etc. TO. 00-110N-1. The tritium markers do not present significant hazard but must be accounted for under present Code of Federal Regulations. One of the latest amendments to 10CFR30 exempts tritium markers that pass certain acceptance requirements. The markers usually consist of tritium bonded to the phosphor and encased in plastic.

(2) Depleted uranium counterweights. The C-140 and C-141 aircraft contain depleted uranium aircraft counterweights. These are located in the ailerons. The counterweights must be plated in order to be exempt from licensing. The Air Force counterweight will be plated. The potential radiation hazards arising from uranium are from inhalation of uranium dusts and external radiation. The external hazards are for all practical purposes due entirely to beta particles. The amount of gamma radiation is negligible and the alpha particles are shielded by the plating. Depleted uranium counterweights with a nickel cadmium plating of 5 mils thickness can be expected to have a surface dosage of beta particles of 125 mrem/hr. A person could therefore hold a uranium counterweight in his bare hands for a total of 12 hours per week for a year without exceeding 75 rem limit

for the extremities. Since the replacement of counterweights is a rare maintenance procedure, it is unlikely that exposures would reach this amount. In order to prevent any possible inhalation problem, the plating should be kept intact.

c. Radiac instrument check source.

(1) Radium, AN/PDR-27 - TO. 11H4-7-3-101. Some problem has been encountered with this lately where people have broken off the plastic stick and have put a new one in the hole. Instrument cases have been found with several broken off radium sticks wedged into the bottom of the rubber storage area. New check sources were then placed on top.

(2) Strontium-90. AN/PDR-39. TO. 11H4-8-3-81(82)(83). These sources contain 1 microcurie of Sr-90. If these are removed they should be handled carefully so that they will not be damaged and begin to leak.

(3) Krypton-85. AN/PDR-43. These represent a minimal hazard but must be accounted for.

d. Luminous dial painting shops. TO's 42A2-1-3. 00-110N-5, and 5-1-5.

(Slide 15)

This is a problem primarily confined to AFLC. Just about every one of the AFLC bases has a shop that does radium dial painting and some also use tritium paints. Prior to painting, the paint must be stripped which can be a messy operation . In the year and a half since I have been at Hq AFLC I know that on three of the bases the radium dial painting shop has been contaminated. On your base, just for fun, you could use a radiac instrument on any dial that glows in the dark. In some cases the people may be using radioactive paint of which they are unaware. One of the daughter products of radium is radon, a gas. This means you can quickly spread contamination.

e. Re-entry vehicles - TO. 11NRV4-2-1(2). Re-entry vehicles contain Krypton-85 batteries. The usual battery contains a vial or container of 450 millicuries of Kr-85. Krypton is an inert gas and does not react, so that the maximum danger occurs when an individual is submerged in an atmosphere of Kr-85 gas. Under the typical maintenance conditions, it would be difficult to build up a sufficient concentration for any length of time. If you should suspect that one of the batteries has released krypton, evacuate the building and ventilate as much as possible for 5 to 10 minutes. The battery does have associated with it a gamma flux of about 30 mr/hr at 3" and less than 5 mr/hr at 12". The primary exposure would be to the wrists. An analysis of exposures of wrist badges indicates that no significant exposures are occurring. You should, however, check the maintenance area where the subassemblies containing Kr-85 batteries are handled.

f. Polonium-210 anti-static bars. TO. 00-11 N-8. Some of the card sorters used in missile card programmers utilize a Po-210 anti-static bar. This bar contains 1700 microcuries of Po-210. It is primarily an alpha hazard and a requirement exists for performing a wipe test. A field evaluation is described in the technical order, using a PAC-1S or PAC-2A. The swipes are then sent to the USAF Radiological Health Laboratory for more sensitive analysis.

g. Industrial radiography. TO. 33B3-1-1. Some of you may become involved with industrial radiography. It is difficult to discuss very much of it except to say that the AEC has a thick pamphlet out describing precautionary measures. There is also a special 10CFR31 which deals exclusively with radiographic sources. If you run into this problem, I will be glad to supply you with the necessary information.

h. Research Isotopes. AFR 160-124. These types of problems are at only a selected group of Air Force bases usually belonging to Air Force Systems Command. Most of the bases having an extensive research program have assigned a health physicist. Again, if you feel you have a problem along this line, I suggest you contact the USAF Radioisotope Committee.

i. Clinical isotopes. AFR 160-57. Here, again, this is a specialized field restricted to about 6 or 8 hospitals in the Air Force. In general, diagnostic quantities do not present much of a problem except with the necessary paperwork required for an AEC license. The AEC quite rightly insists they know who is going to use the isotopes and their experience. Otherwise, the basic principles outlined above apply. The diagnostic quantities are usually in the microcurie range and in most cases the patient is in an out-patient status and waste disposal is no problem. When you increase the program to therapeutic quantities, then the problems increase and special instructions are required for nurses, bed clothing, and sheets. In some cases the patient may have to be isolated due to the high accompanying gamma flux, as in Gold-198 in intracavitary use for pallation of carcinomous patients. This is a subject that could easily take up the whole two hours. If you have a problem along this line, again I ask you to contact the USAF Radioisotope Committee for more detailed information.

j. Medical x-ray. This subject will be discussed by Captain Kendig.

11. Conclusion. And, that, gentlemen, concludes what I have to say. We have time now for about 5 minutes of questions.

RECORDING IONIZING RADIATION DOSAGES

Captain Carnick A. Markarian
Radiological Health Laboratory
Wright-Patterson Air Force Base

Since Colonel Livermore and Captain Weinberg covered some of my material, I'll go ahead and try to give you a little information and orientation as to what we are trying to do at our laboratory, on our film dosimetry program.

I think to put it on a basic level, I'll start out from scratch as if none of your organizations are utilizing the film dosimetry program, and try to show you what we have to do to get this thing going, and done properly. We realize, of course, that since we are dealing with 379 individulas from 379 Air Force bases, everyone likes to use their own methods. However, this is not satisfactory for us. Let's assume that you're coming in for a program, a film badge service program and you write us a letter and we get the letter from you; you are making a request for so many film badge holders for your people to monitor.

The first thing we'll do is indorse your letter to indicate to you, prior to the monitoring program, that we would like to have a registration form filled out on each individual. And on the hand-outs issued is a sample form which you have in front of you, if you have picked them up at the desk in the back.

This is a new Air Force Form 1520; there appears to be a little problem on the base publications office receiving them. You have to make this request through your DPO. We are stocking them on a temporary basis, but you do have to make the request. But anyway we ask you to make this out, there are a lot of pieces of information here that we want, not only for the present, but for the future. It may not look important to you, but it is important to us and the program. After this is filled out, let's say that you come in for 40 film badge holders for your program, we expect 40 registration forms. Our intention is to register everyone in the Air Force as utilizing or working with ionizing radiation and radioactive material.

After we get these forms back, they we will send you the film badge holders and the films and the necessary supplies to run your program. The reason for this, and they are various, is that we are utilizing an awful lot of film badge holders that are not really necessary. Some of the organizations are becoming rat packs, and these things do cost money, and we have to budget for it each year. This is the only way you

can keep control of the film badge holders. They cost $1.82 a piece and when you figure 15, 20, and 25 thousand out in the field this runs into a lot of money.

The supplies that you will receive in the initial request, after we get the registration forms, you will get these IBM cards back with the man's name on it, his command, his base and the base's code, and also social security number. We will send back to the base, a supply for each individual. When you handout the film to the individual, you'll make out this card, as to date, EDC of film. When you finish your markings you will put the date the film was returned to you and his occupational series, whether it is quarterly or other.

Upon submitting this back to our agency, there are about 50% of the bases who are doing a good job on this and about 50% of the other bases who are not. A big base won't even bother to return these properly, as we have instructed them on the instructions. They just throw them in a box; throw the film in the box, the cards are torn, they're creased, and we have to sit and do this all over again, and it wastes a hell of a lot of time. What we ask, as you see in our instructions, is that these be sequenced. We don't care by what order, but by film number. If you have 50 of them, put 50 of them together and sequence your film in the same order. We have to check every film that comes in, so we check the film number against the card for positive identification, and when we do this it makes our job much easier and we can go ahead and process the film. We stick the cards in an IBM 526, the film comes out of the developing program, set right up and automatically when we re-offer them to our electronic-potentiometer it punches the dose on the card. It's that simple, if we can get the cooperation of the people in the field to sequence these cards; this saves days. We can give you 24 hours service, but we cannot if people do not submit these things properly. After the cards are punched by the computer dosimeter we take the cards and stick them in a 402 and comes out with the results and sends back the sheets that you see there. We give the organization, the man's name, social security number, film number and then the dose's reporting period in millirems and the doses in quarter-millirems, and also will give you a total accumulative dose on a quarterly basis. Now for you people who are maintaining an 1141, this total accumulative dose can be very, very important to you whereby you don't have to record on 1141 the monthly dose, the bi-weekly dose; you can if you wish, and if you have time in the small organizations it will be fine, but we can give you the total accumulative dose in millirems for any period of time, and that you can record on your 1141. By adhereing to regulations, and I think this is a matter of communication between you, the supervisor and to the lowest airman, who is doing the job for you. We have known that there is always a breakdown of communications. There are ways and means of communicating, but we have to get to the lower echelon who actually do the work, go

over the program with him, show him how it is to be done, and set up a pattern for him, set up a routine so that he won't deviate from this.

At the present time we are handling approximately 15 thousand people and these 15 thousand people are spread all over the world, and when these supplies come into us, and when the film comes into us we do have a problem. I have 5 people working on this program and this is in total. They are not trained in IBM; we send them to school when we can, everything is OJT, and we need your support very badly. These people have a very tedious job looking at film all day, looking at numbers, it is very hectic and then when people submit as they wish to submit, its really a harrowing experience - it just makes you want to give up.

You will notice in one of the hand-outs there is a list of items of discrepancies that occur. What we were doing at first was to write a letter to each submitting agency to tell them what they were doing wrong to clear up the discrepancies, but when you have about 50% of the bases with discrepancies, you get pretty tired of writing letters and it gets to be very tiring. We made up a list of discrepancies that occur on submission, and the general idea behind this was to show everyone what discrepancies everyone else was making, what errors they were making on submitting the film badges, so this will give them an idea what not to do. For instance scotch tape on dosimeter fronts is the worst thing you can do. We have a hell of a time taking scotch tape off, and upon doing this you rip the film packet and it is light-struck, and this is no good, and you've wasted everyone's time.

I know there are an awful lot of questions. People have been cornering me and I don't think this is the place for it here because we only have 15 min. so I will be around all day to entertain any discussion or any problems that you may have. I don't know if I can give you the answers, but will try to solve it for you or give you some guidance along these lines.

SAAMA'S RESPONSIBILITY IN MANAGING RADIOACTIVE MATERIAL AND RADIAC EQUIPMENT

Mr. Robert Galindo
Kelly Air Force Base, Texas

INTRODUCTION

In an organization as immense and complex as the Air Force, the dissemination of information is often difficult. We, therefore, welcome this opportunity to talk with a group such as this whose interests are directly linked to ours. We at SAAMA in effect form a bridge between the industrial health interests which you represent and the logistics organizations. SAAMA's responsibilities in nuclear materials and radiac equipment management are many and complex. In this short period of time I can only give you a broad brush treatment which I hope will provide sufficient information to give you an additional and useful tool in your work.

NUCLEAR MATERIALS MANAGEMENT

a. Guidance Documents

The primary Air Force guidance documents for nuclear materials are AFR 160-124 and the 00-110N series technical orders. The USAF Radioisotope Committee is responsible for the regulation. SAAMA is responsible for the technical orders. AFR 160-124 provides basic policy on entry of radioactive material into the Air Force. The 00-110N technical orders prescribe how stock listed radioactive items are to be handled within the Air Force and therefore provide detailed instructions on acquisition, handling, and storing, accountability, leak testing and disposal. In fact, these technical orders in most cases become the supporting documents to the Air Force's application for Atomic Energy Commission (AEC) license. Some examples are:

(1) TO 00-110N-1 covering radioactive luminous markers.

(2) TO 00-110N-4 covering magnesium thorium alloys.

(3) TO 00-110N-8 covering radioactive electrostatic eliminators.

(4) TO 00-110N-9 covering nuclear batteries.

The basic technical order in this area is TO-00-110N-3 and it applies to all radioactive materials stock listed or otherwise.

In the preparation of the 00-110N technical orders we obtain our guidance information from numerous organizations. The principal of these are the USAF Radioisotope Committee, Air Force Special Weapons Center and the Atomic Energy Commission. In addition, we use such publications as the Code of Federal Regulations, Federal Radiation Council Reports and National Bureau of Standards Handbooks. We especially use Title 10, Parts 20 and 30 of the Code of Federal Regulations (which are national regulations promulgated by the Atomic Energy Commission) to establish the rules for the control of radioactive materials within the Air Force.

In addition to the preparation of the 00-110N technical orders, we maintain surveillance over field activities through correspondence, personal visits, telephone and other means of communication to determine whether radioactive material is being properly handled and if there are discrepancies and inadequacies in our technical orders. From information gained from these contacts, we make the necessary revisions to our publications. We are on call to provide technical assistance to anyone within the Air Force organization, and on several occasions we have provided assistance to organizations outside of the Air Force, such as State Health Department agencies and the Federal Aviation authority.

b. AEC Licenses

Concerning AEC Licenses, SAAMA is responsible for preparing license applications for all radioactive items which are destined to become standard stock listed commodities and for assisting AF activities in preparing license applications wherein non-stock listed radioactive material is involved. As a matter of interest, I might point out how stock listed radioactive commodities normally enter the AF inventory. Prior to delivery to an item which contains radioactive material, the contractor is required to notify the Administrative Contracting Officer that such an item will be delivered. The ACO then must notify the USAF Radioisotope Committee, and simultaneously notify SAAMA and the inventory manager who will have ultimate logistic support responsibility for that item once it enters the inventory. Then we coordinate with the inventory manager and other concerned agencies to determine operational concepts, leak testing requirements, requisitioning procedures, storage and accountability requirements, etc. From this data we develop and publish a 00-110N technical order which, as I mentioned before, becomes the basic document to the AF's license application. We then prepare the license application, coordinate it with the appropriate AF agencies, and forward it to the USAF Radioisotope Committee who, after review and approval, forwards same to the AEC. When the license is obtained, a copy of the license is furnished the contractor so that he can deliver the radioactive item.

c. Radioactive Waste Disposal.

SAAMA is further responsible for monitoring and operating the Air Force's radioactive waste disposal program. Some three or four years ago the Air Force centralized the waste disposal program at SAAMA. The guidance received from USAF was that with minimum exceptions radioactive waste was to be buried at sea. After considerable study, there evolved the present contractually supported program which is outlined in TO 00-110N-2. Simply stated, SAAMA provides the funds and arranges for contractor disposal points; one on the east coast and one on the west coast. Field activities then report to us the type and amount of waste, method of packaging and radiation readings. Upon review and approval of this data, we provide the reporting activity with shipping instructions.

RADIAC EQUIPMENT MANAGEMENT

a. Procurement and Logistic Support

Moving into the area of radiac equipment, radiac equipment is cataloged in Federal Supply Class 6665. Included in this class are the radioactive sources required to calibrate this equipment; and included also, are other types of hazard detection equipment such as combustible gas indicators, oxygen deficiency analyzers and toxic fume detectors. SAAMA is responsible for the procurement and logistic support of all FSC 6665 equipment which has general application throughout the Air Force. Some examples of radiac equipment in the class are the alpha detectors PAC-1S and PAC-2G; the low level beta-gamma AN/PDR-27; the high level beta-gamma AN/PDR-43; and the semi-portable high level gamma MG-3. Items normally procured through the AFLC system are known as centrally procured items. Such items are either military specification types or commercial types wherein large quantities and special logistic support requirements are involved. For these items, we procure technical data, spare parts, special tools and test equipment. In addition, we assist the commands in developing field level maintenance capabilities, and where required, we establish a depot level maintenance capability within one or more Air Materiel Areas.

b. Radiac Maintenance

Maintenance instructions for FSC 6665 equipment are found in the 11H series technical orders. Maintenance instructions for radiac sets and calibration sources are contained in the 11H4 series technical orders. In most cases, these technical orders are prepared by the equipment manufacturer; in other cases by our office. After publication, however, our office maintains the documents up to date. The basic policy technical order on maintenance of radiac equipment is TO 11H4-1-5.

In regard to actual maintenance responsibilities, I refer you to our specialized repair activity at SAAMA and the Precision Measurement Equipment (PME) Laboratory system. There are approximately 160 PME laboratories throughout the Air Force. These are responsible for field level repair, inspection, and calibration of all low-level radiac equipment. The locations of these labs can be found in TO 33-1-14. Repairs and calibration beyond the laboratories' capability are accomplished by the specialized repair activity at SAAMA. SAAMA has, at the present time, the only high level calibration source in the Air Force. This source is the AN/UDM-1A containing 120 curies of Cesium 137. In the future, we will establish the same calibration capability at SMAMA, MAAMA, and Chateauroux, France. In the Pacific area, Tachikawa has a cross service agreement with the Navy to calibrate our high level instruments.

RELATED MANAGEMENT ASSIGNMENTS

a. Decontamination Procedures

There are some related management assignments which may be of interest to you. For example, SAAMA has the responsibility for compiling and publishing procedures for decontamination of aircraft and material contaminated with fission product debris (fallout). These procedures are found in the 00-110A series technical orders. Aircraft, engines, and accessories are separately dealt with.

b. ECL 459, Set, Chemical, Biological and Radiological Defense Equipment

SAAMA is also responsible for the management of ECL 459 which prescribes allowances for all detection equipment required by base disaster control officers to cope with radiological, chemical and biological agents. In this area, we review, evaluate and approve or disapprove requests for additions, deletions and changes in basis of issue involving detection equipment. We are also normally called upon to evaluate requests for inclusion of hazard detection equipment in other equipment allowance documents. For example, your own ECL 906 and SLOE 091.

c. Nuclear Power Systems

And finally in the nuclear reactor field, SAAMA has the responsibility for procurement of nuclear fuel cores. However, as everyone is aware, the Air Force is preparing to make use of nuclear energy for ground and space power and for propulsion of missiles and spacecraft. As a result, we have in prospect an expansion of our present, responsibility to include logistic support of the Air Force Nuclear Power Program. It is anticipated that this assignment will be made in the not too distant future.

RECOMMENDATIONS

a. Technical Order Files

I have done a good bit of talking about whatwe do. Now I will explain how you can benefit from some of these services. First of all, I strongly recommend that you establish a technical order file containing all the 00-110A and 110N series technical orders, the 11H4-8 technical orders which cover calibration sources, and selected 11H series technical orders which cover the standard hazard detection equipment you may be using. Section VII of TO 00-5-2 provides the procedure to obtain technical orders. Coordinate with your Base Publications Distribution Office to have your needs entered in the publications requirements tables. Since technical orders are revised periodically, it is necessary that you assure your office is placed on automatic distribution if you are to have the latest information available to you.

b. Equipment Acquisition

One thing all of you are interested in is: How can I get equipment without having to pay for it. Gentlemen, anything that is stock listed is available to you at no cost provided that it is entered in an ECL; that it is entered in your UAL and that assets are available. Asset availability is insured by coordination with your supply office and projection of your anticipated requirements in the RCS 3AF-S106 Report. Entry of your requirements in this report is vital as AMA personnel use it to determine the quantity of equipment to be bought. Requisitions may be submitted for equipment appearing in the aforementioned documents. I reiterate, however, if the item being requisitioned is not listed in the ECL or does not appear in the S106 Report, your requisition will in all probability not be honored.

SLOE 091 lists equipment suggested for use by Sanitary and Industrial Hygiene Engineers, but this list reflects only non-standard equipment. Neither our office nor the maintenance shops can support non-standard equipment, as there is no technical data or spare parts available for this equipment. We, therefore, recommend that you use standard equipment whenever possible.

c. SAAMA Commodities Digest

For your additional information, SAAMA publishes and distributes to all bases, a monthly bulletin entitled the "SAAMA Commodities Digest". This periodical contains information concerning all of the products which SAAMA manages. Our office usually enters several articles on existing materials and radiac equipment, on new materials or equipment which we expect to phase into the inventory, and on any item of interest that we think the field would benefit by. I recommend you arrange to be placed on

your bases's distribution list for the digest. This can be accomplished again through your base publications distribution office. Additional copies of the digest may be obtained by the distribution office by contacting SAAMA, Attn: NU-1.

CONCLUSION

a. At this time, I would like to mention some things that you can do that will help us do a better job of serving field activities.

(1) It will benefit us as well as yourselves if you will continue to keep current on changes made in the 160 series Air Force Regulations and with the technical order series which I have discussed.

(2) We are aware that there are a number of radioactive items in the Air Force that we do not know about, i. e., items which have somehow entered the inventory outside established channels, either through error or lack of knowledge of the system. If you should run across any of these items, we would appreciate your letting us know. Our office symbol is SANUS. Our telephone extension is 65243.

(3) We would like for you to continue looking closely at working conditions where radioactive materials are involved, and if you note questionable practices or procedures, we ask that you check with us.

b. In summary, gentlemen, we are in AFLC service organization; the only one in the nuclear business. The purpose of our existance is to serve and support the user organizations. If there is anything we can do to assist you in your work, please do not hesitate to call upon us.

TRI-SERVICE RADIATION PROTECTION STANDARDS

Lt Colonel D. L. Livermore, MC
Headquarters USAF, Surgeon General's Office

Thank you Colonel Dills. I wish to apologize for my rather informal attire this afternoon. I hold this group in high regard and out of respect. I would have been dressed in a blue suit, but as Colonel Dills said, I am speaking today instead of tomorrow. Unfortunately I don't have the Evangelistic mode of presentation General Jenkins does, nonetheless I hope that I can get across a very scintillating discourse on a new regulation.

First, I would like to borrow from Dr. Thomas in his remark with regard to our impact on Air Force Operations when it comes to matters of hazard control and recognize our mission so far as control of these hazards is concerned, not only in protecting the individuals, regarding their health both at present and in the future, but also that we must have cognizance of the impact which our restrictive practices may have on the Air Force operation. We are part of the system, as the old question goes, do you recognize the problem or are you a part of it? The title of this new regulation is Control and Recording Procedures, Occupational Exposure to External Ionizing Radiation. This is a long and weighty title; I'll get into some of the reasons for some of the semantics in just a moment. Referring to General Jenkins' remarks concerning your abilities to blow your own horns, I recognize full well the vital mission which you, the engineers, play in the Health Physics Program within the Air Force Medical Service. Among you sitting here there are a few who have outstanding educational backgrounds in the area of health physics. We go clear down the spectrum from there to those of you who have had no formal education, nonetheless with your sanitary and industrial hygiene engineering background you have the educational basis for picking up all kinds of interesting information and applying it so far as your daily duties are concerned. At base level it is totally incomprehensible that we could assign a health physicist with a Master's degree at each base to take care of the health physics problems. There are not that many problems at an average base. We must reserve the few who do have these educational qualifications for the special assignments where this knowledge and capability is required. Therefore, I am sure you all recognize the fact that when it comes to operation of the Air Force Medical Service Health Physics Program that you are the individuals at the bases who actually are the factors who do the work; and at the major command level it is you, the engineers, who probably do most of the actual operational work in monitoring the health physics program and activities.

Last month 3 representatives of the medical service; one each from the Army, Navy, and Air Force left the Atomic Energy Commission Headquarters in Germantown late in the afternoon and drove toward Washington D.C. Their first stop was the Washingtonion Motel which is the first bar this side of AEC Hq. These three illustrious gentlemen imbibed rather freely to celebrate the fact that after 26 months of concentrated effort, this working group had finally sold the 14th draft of a tri-service regulation to the licensing and regulating authorities in the Atomic Energy Commission. This last session with them fortunately turned out to revolve almost solely around the semantics with the regulation.

In the summer of 1959, President Eisenhower appointed the Federal Radia- Council which is Chaired by the Secretary of Health Education and Welfare and has as members the Secretary of Defense, Secretary of Agriculture, and a few other cabinet members, and probably the Postmaster General - he usually gets into one of these things somewhere. Since the knowledge of this group has of the basic problems of radiation hazards, is somewhat meager at best, a technical level was appointed representing these individuals who engaged in a very prolonged and a very profound study of Radiation Hazards and Control Measures in order to come up with guidance to the President and to federal agencies so far as control of radiation hazards is concerned. On the 13th of May 1960, they published the famous FRC Report No. 1, Radiation Protection Standards. When these Radiation Protection Standards were published they found in them certain numbers which were called radiation protection guides which by virtue of the mission of the committee became the guides for use by all federal agencies. In June, the Department of Defense gave to the three military services the requirement to come up with a joint tri-service regulation. That was 27 months ago. I was the Air Force representative on this three man working group and 27 months ago I predicted that 21 months ago we would have this publication completed. 27 months later we finally got the thing signed off in the preliminary phase from the working group coordinated with various other federal agencies, including the Atomic Energy Commission, the Public Health Service so on, and I think probably the one factor which gives greatest evidence that this is going to be a successful document is the fact that Hyman Rickover said, "I don't like it, but we'll live with it". This publication, or this final draft, draft No. 15 - incidently we even had a number for this regulation in the Air Force already, also the Army and Navy, because of certain profound factors going on in the gackground of this thing, they all coughed up a number for it even though the thing had not been fully developed. This is rather rare in the annals of regulation publication. This regulation will be AFR 161-8 in the main it will replace AFR 160-132 which will not yet be rescinded because there is yet to be some further rewrites on parts of 160-132 which need to exist and which are not covered in the new tri-service regulation. There are a few other regulations which

will supersede existing ones which have already been completed and cannot be published until 161-8 is bought off and published. This draft regulation is now at the DOD level and we anticipate no great problems as far as DOD is concerned. DOD will then send this regulation back to the three services for final coordination. You see, we were a working group; we were not representing our services in actually putting this thing together, so all of us have done our preliminary homework. We expect no difficulty throughout our own headquarters staffs in getting the sign-off on this regulation, and once things get to this point they actually move with amazing rapidity for a place like Washington. I am not going to make any predictions between now in the length of time from now and the time that this will be in your hands. I have served almost three years in Washington, and I have discovered that you just don't predict periods of time. I have too many scars on my neck already from that.

To go into the contents of this regulation, first, I would like to discuss the philosophies behind the standards themselves, the radiation protection guide and the thinking that went into the FRC statements, discussions, and final recommendations. Historically, the International Commission on Radiological Protection established in 1928 established levels of permissable exposure, an unfortunate terminology on the basis of demonstrable damage to the individual within a reasonably short period of time. Historically, this has dropped down from the original high levels of permissable exposure still looking toward damage to the individual; until finally, the national committee on Radiological Protection and Measurements promulgated the philosophy that protective measures should not be related solely to damage to the occupational worker himself, but should be established with due regard for the population as a whole and the subsequent generations. As a result we are talking about radiation levels which are very, very far below the original standards of 30 years ago. We are talking about gonadal exposures in individuals who are still in the child-bearing age group. There is a statement that I am sure will remain in this regulation when it is published which states that the levels, the standards that are prescribed by this regulation for the 3 services shall be construed to be administrative levels for management purposes, and will not be construed to be threshold of deleterious biological effects. We put this in because although we understand this full well ourselves we recognize the fact that since the FRC report was published this will be the first document which has been published with the authority and force that it will have over such a broad group of people; and consequently, is bound to end up in court room litigation somewhere sometime.

We have to recognize our responsibilities to such organizations as the Department of Labor, who are constantly engaged - well, the Veterans Administration for one. I just read a report of a case presented to the

Veterans Administration - an old veteran with chronic leukemia tried to get a claim for disability on the basis of radiation which he had received in routine physical examinations throughout his military career - chest X-rays. That was a Marine Corps Lt Colonel, retired. The Veterans Administration fortunately turned him down on the basis of his claim. They will take care of the fellow adequately because he is a retired military officer, but they would not accept the premise that his Leukemia was the product of radiation exposure during his military career. This regulation will carry the usual paragraphs on purpose, definitions, responsibilities, and all this stuff.

I am not handing out copies of our draft, as I have it in my hand, because it has changed since then, and I don't want anyone to see this thing until it is finally published because these changes, which I have mentioned, are semantic in nature are so important to some people that we just don't want the wrong word to get out. The draft as I have now refers to a Radiation Protection Guide. We are not using that term now, we are going to call them Radiation Protection Standards, because the Radiation Protection Guides are those numbers which the DOD is publishing for DOD purposes, so we have to use a different terminology.

You get Washingtonitis after a while going through all of these things. We went into a considerable hassle over the meaning of 5xN-18, when N is 18. I used to think that was funny too. Being somewhat of a mathematical purist, I said this is totally impossible, therefore, nobody could possibly be exposed occupationally until they reached their 19th birthday. But, that's not what the FRC intended, obviously. Why this is obvious, I don't know. The FRC has not explained to me what they really meant either. We were going to allow a very modest exposure to people under the age of 19 who had already passed their 18th birthday. For a very material reason, in all three of the services, we put brand new enlisted men into training as X-ray and dental technicians. 55% of our input were well below the age of 19 by the time they started school, so we were going to cover this very neatly - we got into such a hassle with AEC that they didn't care about us exposing these people below the age of 19, they said "that's not what the FRC meant". We begged the issue by eliminating the point completely, and when you get this regulation you can read through it very carefully and you will find that there are certain places in which this is absolutely spherical; there are no handles that you can grab onto.

Every single stinking word in this document is bathed in blood!! When you see things in here with which you don't really agree, such as the text starting out with "these regulations", the Air Force and the Navy would naturally say "this regulation", but this was a liver diatonic with the Army; they have to say "these regulations". So the Navy and the Air Force capitulated on that one. The regulation contains an example of

a brand new form. I am sure that you are all familiar with the DD 1141 - the ionizing exposure record. There will be a brand new DD 1141 which will not make any remarks concerning the DT 60's. The new DT 60 regulation which will be published after this one will tell you how to record the DT 60 reading on a little piece of onion skin paper inside the locket itself and nowhere else. If you need a DT 60, who's got the medical records around to refer to anyway!

The format of this 1141 is designed so that the information on it can be transcribed to IBM data processing systems and the Air Force is looked upon with a fair degree of envy by certain other military medical services because we do have an IBM system for central recording of all radiation exposures, and we can dig out our information in a hurry; thanks, to the diligence of Captain Markarian in pushing these things through. Where he didn't get the money to get some of the things he's got in that place, I don't ask questions about! Each one of these 1141's, I am sure this information is going to be bandied about most at base level by you gentlemen, because I am just reasonably sure that you are the fellows that the Hospital Commander is going to saddle with the job of monitoring this thing.

Somebody said to me "but nobody is going to read all that trash in that regulation". I said "yes, they are". We'll find out who is right. There has to be a determination made, of course, of the individual's accumulated occupational dose at the time he comes to work in the Air Force - at the time we start to expose him occupationally.

This DD 1141, incidently, has already been bought-off with no criticism at all; they're real pleased with it, by the Atomic Energy Commission in lieu of the AEC form 4 and 5. It contains all the information they are interested in, plus some more. As far as they are concerned the 1141, as we will show you in a minute, is a fine form. We have taken the liberty of emphasizing that reasonable efforts will be made to determine previous occupational history. By reasonable efforts we mean that you should be reasonable individuals. You can't slow up the progress of the Air Force by going through all kinds of shenanigans, trying to get past occupational exposure records which may be filed in a carton in somebody's warehouse somewhere. This is awfully hard to find, and what you do when you can't get the actual record is all spelled out in the regulation and it is not too different from the AEC regulations in that respect.

We have prescribed something which we did call individual radiation status but due to deference to the AEC we have changed that and I have forgotten exactly what word we did use. We argued about it for about an hour and a half, and I came up with the word which we actually ended up using, but I can remember everybody else's word, but I can't remember my own.

When an individual receives more than this administrative upper level exposure that we are talking about in a certain period of time, this individual is then to be evaluated by a competent authority. This does not say that the man must have a full thorough physical examination. The purpose of this is not- we do not want to impress on people the horrors of radiation exposure at these very, very low levels. This in a sense is almost political, its educational; we want to make sure that people are aware of the fact that ionizing radiation is not good if the exposure is too high. There are some of us who will look back into the past history of life on this planet and recognize the fact that radiation levels in the past, from naturally occurring radio-isotopes, undoubtedly were considerably higher than what they are right now. Ionizing radiation produces genetic mutation .....

That any amount of radiation exposure above the background is deleterious. This is just a philosophy of health physics protection. Obviously the levels to which the exposed people must be weighed against the importance of the activity involved. We give rather high levels of exposure to patients in certain examinations because the benefits derived far out-weigh the hazards involved to the individual.

These numbers that we are talking about in the radiation protection standards are based on the statistical evaluation of populations, rather than the effects on the individual himself. We are reasonably certain that the levels that we are prescribing are so far down that we can anticipate no semantic change in the individual himself, during his life time. After his life time I don't know.

I have brought with me a series of one slide, and with my luck it will probably be out of order. This slide is going to refer to the new form DD 1141. The form itself has instructions printed on the back which duplicate the instructions that will be published in the regulation itself. The top of the form has the normal identification information, and if it dosen't all look like Air Force terminology all the way through like what would seem a reasonable and clear statement, please forgive us, this again is a compromise among the different services. This is a continuing record giving total accumulated doses and is a permanent part of the medical record. It is to be retired with the medical record and never to be destroyed. Because this is the bit of information the individual should always be able to go back and get at any time during his life to find out what his occupational exposure was. Now you'll remember the AEC forms 4 and 5 are supposed to give the individual his history so that if he changes his jobs, the information is available. This is one piece of paper in the medical record which although is in the custody of the medical service we have spelled out that the individual himself, or his supervisor, or responsible inspecting individuals may have access to this document. This is not a privileged

document in the sense of a clinical record. On this thing, the individual himself certifies to the fact that his past exposure history is correct insofar as his times and places of work were concerned. The custodian of the record certifies as to the accuracy of the readings, the entries, that go into it.

Now I could get dry and dusty and go into a lot of detailed pedagogical consideration with regard for filling out of the form, but I would rather leave that to Captain Taschner and the staff at Gunter. I will be available for questions afterwards along with the rest of the people.

RESULTS OF RADIATION SURVEYS

Captain C. J. Weinberg
Hq AFLC Surgeon's Office
Wright-Patterson AFB, Ohio

1. Introduction.

Yesterday afternoon you heard a discussion by Captain Kendig on how to perform a medical x-ray protection survey. In addition, some discussion took place regarding the generation of x-ray from radar sets. This morning I will present to you some of the results obtained by Sanitary and Industrial Hygiene Engineers and Health Physicists of AFLC during the period January 1961 to June 1962.

2. Results of Surveys for X-Radiation from Radar Sites.

a. Survey Technique.

The surveys are performed utilizing three types of instrumentation: a ratemeter-type instrument for locating possible x-radiation fields; a charged condenser-type instrument for more accurately determining the strength of the x-ray field; and film dosimetry, which also provides a permanent record.

b. The results shown on the slide indicate that when cabinet doors are closed no x-radiation hazard existed on the radar sets surveyed (FPS-6, 7, 20, 24, 26, 35, and FRT 49.).

c. A complete description of the survey technique, description of each radar set, and summary of results both inside and outside the cabinets, are included in an Occupational Health Technical Report, Hq AFLC Surgeon, 1 October 1962, "Results of Surveys for X-Radiation from Radar Sites." Sufficient copies are available and you can pick them up on the way to the coffee break.

3. Results of Medical X-Ray Surveys.

a. The medical x-ray facilities were surveyed in order to compare them to the standards expressed in AFM 160-10, "Medical X-Ray Protection," 7 May 1957, and National Bureau of Standards Handbook 76, "Medical X-Ray Protection Up to Three Million Volts," 9 February 1961. In addition, dental x-ray units were required to be modified in accordance with AFP 160-8-188, "Modification of Dental X-Ray Apparatus," 10 April 1958. Only the major areas of concern will be mentioned in this discussion. These are the areas that produce the majority of discrepancies. The above-referenced publications

should be consulted whenever the detailed requirements are desired and they will not be repeated herein. Anyone working in or around medical x-ray facilities should be familiar with these requirements.

b. Dental Surpaks.

In addition to the actual physical survey of x-ray installations, the AFLC Surgeon conducted a trial survey of dental x-ray machines utilizing the US Public Health Service-developed "Dental Surpak." A total of 50 dental x-ray machines were surveyed within AFLC, ADC, and MATS. The dental Surpak consists of an 8x10 film and aluminum stepwedge prepackaged. It is simple to use; the dentist or technicians need only put the end of the cone on the package and expose according to the instructions provided on the cover envelope. This survey technique provides data primarily on the beam filtration and the beam diameter characteristics.

c. Results and Discussion.

Table I lists the major areas of concern and indicates the percent of units surveyed that did not meet minimal requirements.

Three major conclusions can be drawn from the data:

(1) A surprisingly large number of Air Force radiographic facilities do not meet minimum requirements of AFM 160-10 and NBS Handbook 76.

(2) The majority of discrepancies were such that they could have been found and corrected solely by visual survey without utilizing radiation detection instrumentation.

(3) Special training in radiation protection surveys is not required to recognize the major discrepancies. In fact, they should have been found and corrected by both the technicians and the physicians utilizing the facilities.

d. The major areas of concern are:

Beam filtration
Beam collimnation
Tube Housing
Operator's station
Fluroscopic beam
Protective equipment
Film badge program
Room shielding - medical/dental
Dental Surpaks - beam size/beam filtration.

MEDICAL SUPPORT OF THE PM-1, NUCLEAR POWER PLANT

1st Lt. James R. Lewis
Surgeon's Office
29 Air Division (SAGE)

At last year's symposium, we were privileged to hear Colonel Bovee of Hq ADC present a paper on the medical planning for the PM-1 Nuclear Power Plant at Sundance, Wyoming. In his presentation, he outlined the type of medical examinations given to reactor personnel, precautions taken during reactor operation and considerations given to the health of the population at large.

Today I should like to give you a synopsis of what has transpired over the past year, covering what plans have worked and the programs that have needed revision. Most of all, I would like to stress why we have taken specific actions, and what shortcuts we have found through operational experience. It is hoped that the knowledge we have gained in support of the PM-1 shall be of value to others when the day comes that heat and power requirements will be routinely provided by nuclear reactors at isolated locations.

First, allow me to summarize the basic data regarding the PM-1. It is a portable, medium range, pressurized water reactor and the first of its type, hence the initials PM-1. The net electrical output is 1000 KW and the heat output is 7 million BTU per hour. This power is used to operate the radar equipment and heat the buildings in the operations area.

Medical Service interest in the PM-1 is obvious and stems from paragraph 2d, AFR 160-132, which requires the Medical Service to provide commanders at all echelons with advice and recommendations concerning the control of radiological health hazards. The basis of this paper is how we have attempted to carry out this responsibility at Division and Squadron levels.

As soon as our Division became involved with the PM-1, in June 1961, it became obvious that personnel more knowledgeable than independent duty technicians would have to be provided. Initially, the unit manning document provided only for the normal component of two (2) medical technicians. To increase our surveillance capability, this was supplemented by the addition of a preventive medicine technician. Within the PM-1 crew itself were four (4) Health Physics-PM-1 Operator slots. These technicians are actual operators of the plant and have no connection with the Medical Service, although they have duties and responsibilities closely paralleling those of the Medical Service. Therefore, it became necessary to delineate our responsibilities and those of the Health Physics Technicians in order to avoid wasted duplication of effort, and yet provide necessary checks insuring

adequate protective measures. It was not believed that the Medical Service should be involved in the actual operation of the reactor any more than we operate water treatment plants. Thus, it was decided that the Medical Service would be responsible for the effect of the reactor on the environs only, and leave the reactor operation and protection of the crew to the Health Physics Technicians. However, this was unworkable and quickly changed, simply because the Medical Service still has a basic responsibility for the health of all personnel, including the PM-1 crew.

The next problem was to develop a workable and orderly program, incorporating all information and guidance furnished our headquarters. This data was combined and published as 29 Air Division Regulation 161-1. Most of this regulation was based upon discussions with the Surgeon's Office, ADC and advice obtained from AFLC, both of which were greatly appreciated. The regulation delineated procedures for the environmental monitoring program, the film badge program, the bio-assey program, and routine surveys of the reactor area. Also included are sections on emergency procedures, reports required and records to be maintained. Even though this regulation is only a little over a year from conception, it is already in need of revision, mainly due to changes necessitated by operating experience.

As a part of our environmental monitoring program, we collect samples at 29 sampling stations located around the PM-1 out to a distance of about 18 miles. Of course, the greatest number of these points (14) are within 3 miles of the reactor. At each site, soil, vegetation and (where available) water samples are collected. These samples are collected in accordance with instructions from the USAF Radiological Health Laboratory. After collection, the samples are split with half going to the Radiological Health Laboratory, where they are analyzed for gross alpha and gross beta, and half sent to the State of Wyoming, Department of Health. Duplicating the samples is done for three (3) reasons:

1. It gives the State of Wyoming an independent set of data from which they can fulfill their requirements for insuring the safe operation of the PM-1. If we did not send these samples, they would have to collect their own at various monitoring stations. This saves a duplication of effort.

2. It enables us to work closely with local health authorities.

3. It gives the Air Force an independent set of data from which it can compare its own findings. This would have great value in case of litigation. Without an independent set of data, we would have environmental samples around an Air Force reactor collected by Air Force personnel, analyzed by Air Force technicians and the data reported

through Air Force information channels. Obviously, it is well that we can substantiate our results through an independent body.

In 1959, an initial background survey of the surroundings of the PM-1 was made by the Health Physics Division of the Martin-Marietta Corporation, contractor for the PM-1. It is from this initial survey that we obtained the locations of most of our sampling points as an effort was made to locate our stations at spots corresponding to those initially surveyed by Martin-Marietta. This was done to give us a broader basis for the pro-operational condition of the environs. Other pre-operational surveys have consisted of a natural radiation survey by the AEC in August 1961, an Air Force survey by our medical technician in September 1961, and a repeat Air Force survey in January 1962. Some of the samples collected in January showed a marked increase in activity. As is normal procedure with inordinately high results, duplicate samples were obtained and these showed a return to normalcy. Most probably, the high results were due to fallout from atmospheric testing. Our routine post-operational plans consist of water samples being collected monthly and complete rounds being made quarterly. Maintaining this schedule has become quite a problem.

The sampling points were selected during the summertime and in the winter it is virtually impossible to get back to them as they are accessible only by logging roads and fire trails. Consequently, we have some gaps in our data due to the impossibility of obtaining remote samples.

It seems as if we invest quite a bit of time and effort in collecting environmental samples without achieving a great deal of benefit from them. It is obvious that any sizeable release would not be rapidly discovered by environmental samples, simply because it takes about a month for the samples to be collected and processed. However, the samples give us an idea of what effect the operation of the reactor is having on its environs and probably, their most important function is to insure that the reactor is conforming to legal limitations and to provide us with legal evidence in the event of claim.

As you may have noted, we have not taken any samples of animal life in the area. Every October, just before the opening of deer season, I become convinced that it should be an integral part of our program that the Sanitary and Industrial Hygiene Engineer collect representative samples of animal life for analysis. Of course, it would probably be necessary to collect one sample in each quadrant as only the horns and tail would be suitable for such analysis. I have suggested such a program to ADC and have been told that it is of such vital importance that it can only be carried out at command level. To be serious, we do not carry out any fauna sampling because it is believed that as long as other parameters of reactor operation (i.e. environmental samples) indicate minimal release, there should be minimal uptake by the animal life.

Other precautions taken, not necessarily by the Medical Service, to monitor and limit the exposure to the population at large is an air monitoring system. The off gas of the reactor is monitored by Health Physics Technicians as a part of the normal operation of the plant. Also, routinely Medical Service personnel and Health Physics Technicians take air samples in the town of Sundance, in the cantonement area, and in the reactor area. This is about the sum total of our environmental monitoring program. Of course, inside the plant, the radiation levels are closely checked by the Health Physics Technicians.

We have had few problems in the area of personnel monitoring. Currently, all reactor operators are monitored with a weekly neutron badge and a beta-gamma badge which contains bi-weekly and quarterly film. These are provided and serviced by the Medical Service and are supplemented by pencil desimeters provided by the Health Physics component. Also, individual operations are monitored with survey meters and exposure times by the Health Physics Technicians. Visitors are monitored on a one time basis with a badge containing beta-gamma film and neutron film. During January and February, the bi-weekly film showed inexplicably high values, up to 285mr, being as no high level source was as yet on site. The mystery deepened when the corresponding quarterly films gave results of "less than 50mr". Investigations by Lt. R. Thomas of the Radiological Health Laboratory showed one series of film being heat fogged which was initially misinterpreted as a radiation exposure. This solved the puzzle.

Heat damage to films has been quite troublesome as we have had all our quarterly film so damaged over the first two quarters of this year. Another problem has been discrepancies of a large order between film badge results and exposures recorded by desimeters substantiated by meter readings and exposure times. To pinpoint the sources of error so that we may correct them, we are again asking for the Health Physics Consultant Services of AFLC to study our complete film badge program.

The bio-assay program has been running smoothly. Before reactor personnel reach Sundance, they undergo a thorough physical including a whole body count at Walter Reed Army Hospital. Those physicals, except for the whole body counts, are repeated annually at Ellsworth AFB. Annual whole body counts are conducted at Denver by the State of Colorado. Urine samples are taken semi-annually.

The third area of our surveillance, routine survey of the plant itself, has found rocky going. As set up, our technicians should visit the plant weekly and make a cursory check of the radiation levels and observe compliance with health physics regulations. So far, they have shown a reticence to do this, as they do not feel capable of monitoring the reactor and are rather awed by the complexity of it. As their training in this field is limited, especially when compared to the experience of the

Health Physics Technicians, they have been unwilling to attempt to act as a check on the Health Physics Technicians. For this, I cannot blame them as I would also feel presumptious in attempting to monitor their program, considering the extensive instrumentation and experience they have at their disposal. The only solution I can see to this problem is to better train our preventive medicine technicians to understand and deal with radiological hazards incident to the use of nuclear power and radio-isotopes.

Our relations with public health agencies have been excellent. This was not by accident, but by pursuing a vigorous program to keep local health authorities informed of our actions. Most of this liaison was carried out at command level and has included conferences at Hq ADC and at Sundance itself where the Air Force was able to present plans for reactor operation to state and local health officers of Wyoming and neighboring states. Semi-annually, we compile all our data from our environmental monitoring program and send it to the Wyoming Department of Health. This is done to keep them informed and enable them to inturn inform their citizens about the reactor operation. In this respect, we borrowed from the people at Savannah River who have had excellent results in avoiding claims and unfavorable publicity by keeping the public well informed.

In summary, it can be said that medical planning for support of the PM-1 has been quite satisfactory. We have encountered several technical problems, but as yet, nothing of a vital nature.

NEW HORIZONS OF ENGINEERING IN ENVIRONMENTAL HEALTH

Colonel Alvin F. Meyer, Jr, P.E.
Senior Biomedical Engineer
Office of the Surgeon General, USAF

Before we talk about new horizons, perhaps we need a starting point, and the starting point might well be the discussion of some basic philosophy. We can then enter into a discussion as to what the new horizons are, and how we might undertake approaching these horizons. One of the first things that one needs to know and which applies to both research and development, as well as to progress of a scientific discipline, is the present state-of-the-art, or established order of things. This is the starting point.

Now, as the tide of events moves on, one will develop some facts which are perhaps (in a manner of expression) to the left or to the right of the known state and which seem to establish a new pattern. At the initial time that this "omen" or change is occurring, it may be difficult to discern exactly what is happening..

As an example of this, let us take the question of establishment of threshold limit values or permissible exposures, as discussed by Dr. Thomas yesterday. In the early days of the use of a new material you may not know how dangerous a substance it is. You have certain determinations which may make you think, "Yes, this will require very restrictive requirements and yet, on the other hand, maybe we are overstating the hazard". You have a lot of doubt. As shown in Figure 1, there is a widespread of initial results of tests.

As you proceed further along in time, perhaps Figure 2 is the picture that begins to develop. As a matter of fact, it is rather difficult even after some further studies, in some circumstances, to determine just exactly in which direction you are heading because of the overlap in findings which can occur.

Ultimately the stream of events and findings begin to indicate one way or the other as to what the true situation is, (See Figure 3), in regard to new horizons of engineering in environmental health, something very similar to this exists as in the continuing evolution of our professional discipline. As new demands result from a changing society and technology, we reach new starting points, or base lines of knowledge and endeavor.

One of the things one must keep in mind is that in the dynamic technological society of today, the corporate body of technical details

becomes outmoded about every ten years. There may be those of you who disagree with this. A little reflection will indicate, however, some of the areas of concern in which we are vitally interested, such as noise and radiation.

The problems and gaps in knowledge of ten years ago are really "old hat" and out of date today. The problems that we are dealing with today as great new exotic problems are going to be quite simple to handle and deal with ten years from now. As a matter of fact, it has been estimated that the basic knowledge available to us expands several orders of magnitude every 10 years, and as these sources of basic knowledge expand, so then we develop new specializations. This is one of the big problems with which we are faced. The amount of knowledge available in the field of acoustics alone, to cite an example, is such that these can develop a completely unique specialization in the field of noise and noise control. The same is true of many other areas of concern to the engineer in environmental health work.

This also presents a problem to the generalist. Most of us in this room are generalists. There are, also, a few easily identified, highly competent specialists. A generalist can also be a highly competent general practitioner, with some degree of specialization in certain areas of practice. This is the inevitable result of an expanding base of knowledge. This situation affects every branch of the engineering profession.

Perhaps some definitions and some postulation of theorems are in order. General Jennings' paper contained a definition of "engineer". One can also define the engineer as one who practices the art and science of controlling forces of nature for man's well being. One must make the distinction between an engineer and a scientist. The engineer uses intuitive judgment, whereas the scientist tries to find new knowledge. The engineer in turn uses this knowledge in arriving at decisions and judgment.

The borderline, however, between the two is often fuzzy and indistinct, especially in the area of concern for health protection, health promotion and human effectiveness. These require art and science as well as engineering judgment. Some further generalizations may also be of value. It has been said that science, which is the study of the behavior of materials and forces including man, can move no further and no faster than the art of measurement.

Measurement involves the language of mathematics. Engineers are users of scientific knowledge, and also are trained in measurement techniques, and the language of mathematics.

In the fields of medicine and the effect of environment on man, a major

opportunity exists for new activity and new contributions by engineers. The engineer possessing a knowledge of biology and ecology, a knowledge of instrumentation techniques and an understanding of physiology, now has the opportunity to make many contributions. In the health professions and life sciences there is an interesting area of activity of which we must be aware and further prepare ourselves to meet new responsibilities for professional practice.

There are some new definitions affecting our profession, such as biomedical engineering. This is defined by the Engineers Joint Council as the application of engineering knowledge and technique, in conjunction with an understanding of biological science, to the improvement of medical art and science and for the promotion of health and efficiency. It includes, among other things, the application of electronics to medical diagnosis and treatment, and in a broad sense the detection and control (in the environment) of physical, chemical and biological stresses on man. It is the direct application of engineering science to medical technology.

Those of us who are practitioners in the field of industrial hygiene know that we are engaged in a science and art devoted to the recognition, evaluation and control of stresses arising in or from the occupational environment. These may cause sickness, impaired health and well-being or cause significant discomfort and inefficiency among workers or members of a community. In the past we have primarily oriented our efforts and our special competence toward the production lines and the occupationally exposed worker. We are equipped, however, by virtue of our background and our training to undertake activity in the broader area of biomedical science.

There is a need for engineers to have a better appreciation of the complex forces and stresses in the environment and man's response thereto. If one wants to draw a typical engineering chart of the relationship between environmental stress and human response, you get a picture similar to Figure 4. We can define environmental stresses rather finitely. We can even specify by engineering means the stresses which we will allow in the environment. As an example, we can say this room should have so many air changes per hour and is to be controlled by certain relative humidity and temperature. This we can do, and further we can make fairly precise measurements to ascertain if our design criteria have in fact been met.

Man's responses, on the other hand, are rather variable. Man is a variable both physiologically and psychologically from day to day, as well as from year to year. But, be that as it may, certain general response characteristics can be stated and defined. In an environment

in which there are minimal stresses, man will respond, depending upon the variation in individuals, as being in a "comfortable" situation. If the stress is mild, the response may be one of "irritation". If we have moderate stress, the result may be degraded performance, or even disability. Depending on the degree of increasing severity of stress, the response may be delayed, or it may occur in a short time or even be immediate. If severe enough the result is illness or death.

Now, at first blush, it would appear that there are enough challenges in the traditional areas of concern of the Industrial Hygiene Engineer and other scientists engaged in health protection and health promotion resulting from new techniques, new problems such as highly toxic chemicals, ionizing radiation, and so on. It would appear that there is enough to absorb all our effort. However, in the aerospace environment with which we are vitally concerned in the Air Force, there are a number of problem areas to which our techniques, our skills and our competence can and should be applied.

Among these there is the problem of acceleration. There is the problem of weightlessness and the problem of vibration, shock and noise in aerospace vehicles. There are problems of isolation, confinement and fatigue. There are problems relating to microwaves, visible light and the interesting and challenging field of lasers, in which the Air Force has a definite and tremendous interest and which, I might point out, are also very interesting problems from the industrial veiwpoint. We have new problems of radiation, all the way from fission product contamination through nuclear power and propulsion devices.

In the field of closed environments there is a wide variety of areas of activity and concern for people with engineering training, coupled with physiological and biological knowledge. This includes atmospheric composition, temperature and pressure phenomena, the requirement for the provision of water and the removal of waste products, and toxicity. (As a matter of fact, one of the more interesting toxicity problems is the outgasing of paints and materials inside a closed environment). Not just in space vehicles, but in industry and in the rest of the aerospace environment, such as the launch control center, we have closed-in areas in which these problems exist. I could go through a whole host of other areas, but I think I have cited enough to at least stimulate your imagination.

Now, what should be the role of the engineer in this? His first work with his colleagues in medicine, and those in the "life sciences" is to apply his skills and special competence to do the following: First, to analyze what the problems are. As engineers we are analytically trained. We should find out where the exposures may occur to any of the possible stresses and we need to develop better means to measure

and define these stresses. Knowing the stress factors, the engineer determines potential severity, and the location and numbers of exposed populations. We should have the competence to determine possible courses of action, to evaluate them, and to make recommended solutions. We must also have the capability of following-up to see that our judgment was right.

Now, to these, we must add the need for greater application of specialized engineering skills in relation to human performance and health protection, and this in the USAF brings us into a greater association with those concerned with research and development of operational Air Force systems. We must, indeed, have a bridge between those concerned with hardware and those who are responsible for technical area management. This is an area in which we must do more.

At the same time, while we are concentrating on these so-called "newer horizons" (which are merely extensions of our existing capability and performance requirements) one cannot overlook the fact of the need for greater application and effort in applying new knowledge to some old basic environmental health and industrial hygiene problems. When in civilian life one can have one of the richest counties in the United States with $65,000 homes rendered uninhabitable because of septic tank back-up, one cannot help but face the fact that we have not solved all of the basic problems yet.

There also are some traditional problems in the aerospace age. As an example, it has been brought to our attention that we are still having difficulty getting potable water in certain of our missile installations. While we are concerned with new problems, perhaps in the broadening of our capability of basic science and basic knowledge we may discern better ways of attacking these fundamentals.

It is apparent, as Colonel Boysen and I suggested ten years ago in a paper entitled "The USAF Physician-Engineer Team--An Evaluation of the Future," there are new education and training approaches required, if we are to provide the proficiency necessary to meet these requirements. In addition to engineering and the environment per se, there is now arising a need for engineers with the capability to work with physicians on the problems of application of engineering techniques to diagnosis and treatment, as well as medical facility and hospital design. In these areas we are devoting a great deal of effort to broadening out our career field.

It is recognized that the competence of the engineer in meeting the needs described above may not be thoroughly recognized either by ourselves or our physician and scientific colleagues. The solution in this lies in a greater effort, on our part, to develop the ability to intercommunicate within the varied disciplines.

In conclusion, I have discussed with you some general philosophy and cited some needs. In essence, it boils down to this: The engineer is well grounded in basic science and applied engineering. If he has proceeded through the proper educational pattern he is gifted with an inquiring mind. He also has the ability to communicate in the language of mathematics. If he will add to this the ability to speak the language of his colleagues in the health promotion and health protection area, he will find that his horizons are limited only by his initiative, imagination and willingness to explore new areas. This is no easy road. There are many problems ahead, but the importance of the contribution of engineering competence in some of the areas discussed above is of such a nature that we must, indeed, beseech each one to apply himself to undertake this task diligently. There are new horizons. They are restricted only by where we want to go.

EQUIPMENT PROCUREMENT ACTIONS - FY 64

BASE DETERMINATION OF REQUIREMENTS:

NOV - DEC 62 → SUBMISSION OF BASE AUTH CHANGE REQUESTS:

DEC 62 - JAN 63 → SUBMISSION OF BASE FINANCIAL PLAN:

PRESIDENT'S MSG TO CONGRESS:

BOGEY FURNISHED TO COMMANDS:

JAN 63 → COMMAND REVIEW OF FIN PLAN:

FEB - MAR 63 → USAF REVIEW OF FIN PLAN:

APR - MAY 63

APPROVED PLAN RETURNED TO BASE:

JUN - JUL 63 → ABA FURNISHED BASE:

JUL 63 → PROCUREMENT ACTION PHASED QUARTERLY

JUL 63 - JUN 64 → REVISED REQUIREMENTS ACTION

AUG - NOV 63

82

Hand Out
San-Ind Hygiene Eng Symp
12 Oct 62
Sangster - SAC - SUA2

SUPPLY SUPPORT PROCEDURES

Lt Colonel Maynard A. Sangster, USAF, MSC
HQS SAC

GENTLEMEN

What I have to tell you will not take the 15 minutes allotted on the agenda.

Certainly it will not take that long to make fully qualified supply officers out of each and every one of you because we all know to be a supply officer you merely take an oath to a creed of philosophy that goes something like this:

Even if I had it I wouldn't give it to you - but I don't have it - I can't get it - it is not authorized and if you did justify it we would not have the $_____ and besides that I don't think you need it because your predecessor didn't have one!

Tho I say this in jest I also know that some of you gentlemen believe this is really the criteria by which a supply man is measured. Be assured that THIS IS NOT SO .

For nearly 27 years I have been directly related to military medical supply and I know most of the supply officers above the grade of 2nd Lt in the Air Force in addition to a great number of 2nd Lts. None of these officers operate under the philosophy just mentioned.

But I did not come here to tell you how long I have been in service or how many people I know ---------

I would like to make two points:

1. Show you what must be done to get the supply support you want.

2. To show you what you can do to help improve your supply support.

If you will refer to your hand out entitled "Equipment Procurement Actions," it might be easier to follow since we must relate equipment procurement to the budget -------

Here now are a few basic rules:

RULE 1.

To get the supply support you want you must program your dollar requirements. Starting in the upper left hand corner notice that if you start to

program in Oct/Nov/Dec 1962 you have no right to expect to receive that item until 8 - 12 months later. You may well ask why - but remember it takes money to buy material - and by again referring to the Chart you will note the steps and time phasing actions required to obtain these dollars.

RULE 2.

To support these money requirements you must have the item of equipment approved on your UAL. UAL approval can be obtained prior to or concurrent with the request for money!

But, for every rule there is an exception:

FIRST - emergency or unforeseen requirements. We know these situations arise and to satisfy them it means we have to defer procurement of some other item or service. To cope with this we reflect the money requirement in a revised financial plan 10 - 12 months later.

SECONDLY - We might be able to obtain an unprogrammed item by reprogramming of money. This means we use the money intended for another purpose but the restrictions on this type of action are usually severe.

With this very brief and over simplified treatment of money relationship to materiel procurement I would like to make the most important point for you to remember. That is:

How you as individuals can improve your supply support to do this requires some "do's" and "don'ts".
DO THIS - tell your supply officer exactly what you want. If it is a non-catalogued item we call it non-stock listed - tell him who makes it - the model number and the estimated cost. If you don't have this information ask him to help you get it. But bear in mind if you don't tell him exactly what you want you will probably not get it. BE SPECIFIC.

ANOTHER DO - Be sure you tell him the MSO in writing - why? Most supply men are willing to accept requests made at the bar, in the hallway and on the golf course - but chances are he will forget exactly what you requested. Don't expect him to decide what you want.

And finally, what I think is most important -
Don't let your supply man write your justification!
You and only you know what you want - why it is needed - why it is superior to any similar item and all the other reasons you cannot do your job without it. Certainly it is a forgone conclusion that the degree

of importance or urgency that you attach to your requirement will be somewhat greater than he will attach to the requirements of the man who makes his ER. So if you help your supply officer you will certainly help yourself.

To summarize - good supply support is yours for the asking - but ask you must. To obtain it you must get it approved, programmed and ordered or requested. As individuals each of you play a key part in these actions.

DOLLARS AND SENSE

Colonel William F. Shutt, Jr., MSC
USAF Hospital, Andrews
Andrews AFB, D. C.

Colonel Dills, Gentlemen:

The invitation extended me in May by Colonel Dills to speak on a general subject under the title of "Dollars and Sense" was most flattering. There were, however, some sticky aspects. I would be living on the East Coast at the time of the meeting and it just didn't make much SENSE and would take too many DOLLARS to make the trip defeating any theme of value. Colonel Dills assured me that the trip would be of value.

I still am not sure. Should I speak of more SENSE and fewer DOLLARS? Those who have been around me for any time would, with a certain air of resignation, confirm that this would be in keeping with my routine sermons on the value of planning and programming. Coming here from Washington, D. C. and speaking on more DOLLARS and less SENSE might confirm in some of the conservative members of this group the opinion that everyone in Washington becomes contaminated with an unpragmatic liberalism.

Several years ago, Captain Bell asked that I speak to a meeting of engineers on the subject of the Second Air Force dollar. I proposed to make a simple statement that there were dollars in Second Air Force and that they were distributed each year on the basis of a set of changing rules and that if one of the engineers ever solved these rules they would again be changed. This probably is a good statement to make again. Captain Bell didn't let me get away that easily and let's face it- with what I've said so far, I haven't paid for Lt. Carter's postage on the letters to me asking that I send my security clearance.

There is a cliche - Proper Planning Pays - which is a verity insofar as you and I are concerned. Do you know what the mission of your base is? Do you know what the mission of your unit is? Do you know what responsibilities and functions you must fulfill in order that you will do your part of the unit mission and the base mission?

Bless you if you do. You can then begin to plan. A plan is a simple arrangement of Who?, What?, Where?, When?, How?.

So your task is no different than that of any of the other seventy engineers in this room. Or is it? In the late great hate one medical battalion was like another medical battalion and the same tables applied and a complete set of equipment could theoretically be shipped to a new unit without anyone

in the new unit deciding Who?, What?, Where?, When?, How? Now, I know it didn't work like that, but it does make a point. A number of engineers have asked me upon occasion, "If you all are so smart and know what we need, why don't you just issue it to us?" I always answered that question by changing the subject.

So we are agreed you have to plan. When you rationalize the Who?, you must consider time and distance involved in daily work and the amount of survey work required in a given period. This will form the basis of your manpower requirements. Remember that each man year represents a definite cost in dollars. Is the work you are planning authorized? Is it required by directive? If required by directive, is it essential at your base? Never assume that a requested space which is unfilled isn't costing anything. Someplace the recruiting service and the technical school are recruiting or training against that authorization.

From personal experience, I can state that the poorest personnel situation in which you can find yourself is with one man too many. You will get much less work from all of your personnel under those circumstances.

Use your technicians hard. Give them more than forty-hours work each week. A busy man is a happy man and a productive man. This may not save dollars but it makes sense. Assign each man a specific responsibility-not just to assist. This is the only practical method of determining whether or not a technician is worthy of retention and of promotion. This opportunity afforded each man will also keep you on your toes as you develop a section of tigers.

As soon as I mention Where? I realize I re-open the argument about transportation. I agree with you - each preventive medicine technician should have a staff car, fully airconditioned, with a driver. You must justify on a use basis the transportation you require. A statement-to pick up water samples-while correct, will scarcely get you a vehicle on twenty-four hour dispatch. Be sure that your use of the transportation - once the justification has been successful - is in agreement with that justification. You will not ever get a second chance on that firing line.

This covers in part the When? of your planning. The When? should have a regular application. A manager of resources at a higher level cannot help but feel that he has been guilty of mismanagement when he has diverted resources for what is ostensibly a recurring requirement to find that use once or twice satisfied all the curiosity and that there will not be any further utilization of those resources. I cannot help but wonder at some of the programs which you and I have conceived in recent years which were to be the finest thing since sliced bread, but which we neglected by inattention or by enchantment in something newer and finer. Did we plan well? Were we thorough in analyzing all the possibilities?

I am now down to equipment. There are equipment component lists, shortly to become almost useless when converted to a single source document. These documents state what, in general, you should have. All right! Look them up, determine whether or not you need the equipment item to do the How? in your planning. You should not have any requirement to spell out your need for this equipment if in fact you do have a requirement.

The equipment which isn't on a source document becomes a different problem. For this you must introduce the requirement into the financial plan through presentation of an adequate justification. What does constitute an adequate justification? Manifestly if your request is acknowledged and funds are provided the justification was adequate.

I have my own definition: An adequate justification is a page and a half - and I can justify this definition in a page and a half. In the page and a half, you must tell what you are required to do, how you plan to do it, and how the requested equipment will permit you to do it. Please also provide a statement as to what will happen if you don't get the equipment and what, if any, equipment will become excess if the new equipment is purchased.

In my time I have been as guilty as each of you in justifying an item on the basis of I need it because I need it. This dosen't sell very well and not only because it isn't a page and a half.

The same rationale must be applied to request for temporary duty. It is my observation that engineers travel more than any other group - other than Medical Unit Commanders, that is.

The intent is to become very expert in your field. This is quite commendable however, remember the old story about the man who learned more and more about less and less until he knew everything about nothing.

Allow me to introduce one non-expert and unwelcome thought.
Since the Sanitary and Industrial Hygiene Engineers of the Air Force have willingly or unwillingly accepted or been forced to accept much of the responsibility for the preventive medicine function at base level it is incumbent that this responsibility be satisfied or you will find the Army with more aircraft than the Air Force - if this rather obtuse thought can get through.

Someone - and that generally means you - must keep statistics on morbidity. Who and how many become ill from what. Analyze this each month, each quarter, each year. If you don't, who will? Is the admission rate higher at your base than at the base down the road one hundred miles? Why? Is the admission rate for accidents higher? Why?

Remember - the mission of the Air Force Medical Service is to keep the combat capability of the Air Force personnel high. This is the reason you were needed in the Air Force and the reason I am in the Air Force. The ultimate and the primary objective from a DOLLARS and SENSE standpoint is that by your efforts the good health of the personnel of the Air Force is maintained and that thereby the United States Air Force can meet the challenges of this time.

DOLLARS AND SENSE

Joseph F. Kopas, Lt Colonel, USAF, MSC
Hqs SAC, Surgeon's Office

Gentlemen, may I begin by stating that this presentation isn't original. Much of the data and the philosophy was obtained from material published by high ranking officials in the U.S. Air Force. The only changes made is the order selected in presenting their salient philosophies. Further, I have added a few comments of my own. Although I don't enjoy pride of authorship, it doesn't matter providing all of you get the message that is intended in the theme this morning, namely, "Dollars and Sense".

May I begin by reading Article 12 of the Magna Carta in Britian during the year of 1217, and I quote: "No tax or rate shall be imposed in the kingdom unless by the common council of the realm, except for the purpose of ransoming the king's person, making his first born son a Knight, and marrying his eldest daughter once, and the aids for this purpose shall be reasonable." The good people of Britian decided that the King needed to be told what he could expect in the way of financial support. It is interesting to note that even kings lived in an environment of not quite enough, in that, no provision was made for knighting any but his first born son or for the marriage of other than his eldest daughter, and her only but once. Tolerable or not, the King knew just where he stood.

In close analogy, the Air Force concept of preparing the annual Financial Plan with the monetary limitations has been applied for a number of years. Let's take a closer look at its purpose. With the issuance of the annual call for the Financial Plans, which occurs sometimes in January and coincides with the President's Message to Congress, you receive an indication of approximately the amount of money you can reasonably expect to receive. This amount of money is commonly known as the "Bogey" which you have probably heard referred to many times in the budgetary circles. There are a few things to know about this "Bogey". Just how valid is it? Well, it all begins in the budget cycle with the President's presentation of the Annual Finances to Congress for the ensuing fiscal year. The Air Force knows at that time how much the President has asked in his message for the operation and maintenance of the Air Force. We can wait until the Congressional cycle has run its course and funds are enacted into public law and finally apportioned by the Bureau of the Budget, or attempt to forecast the Congressional action. We can reasonably assume the Air Force will not receive more than contained in the President's message. Using this as a basis, the Air Force can predict accurately within one or two per cent the actual amount that will be made available within the next 5 or 6 months. This, gentlemen, is the beginning of the philosophy of the "Bogey". The "Bogey" is issued to you by Budget Project. This means that the distribution of funds are identified as medical funds in lump sum, so you can convert your program into

dollar requirements which are finally expressed in the financial plan. One thing for certain, with this "Bogey" you have a basis for deliberate planning and you certainly have the time to permit evaluation and consolidation of the various priorities in your local program.

Now that the means have been provided you for prior planning, it is logical to expect that you will give the higher headquarters specific decisions and guidance on the program. There is no doubt in higher headquarters concerning the use of field submissions in arriving at the ultimate decision and in the distribution of funds. The documents you gentlemen prepare are presented in the final form in a Financial Plan which becomes one of the most significant documents in the deliberation of the Air Staff. I feel certain that there is no doubt in the field concerning the use of Financial Plans and the screening that they undergo. Often during our informal conversations we are prone to disregard some basic mathematical principles. We form a habit of posing impossible problems with both sides of the equation unknown. For example, we exert ourselves to get more program for less dollars, cost consciousness, more bang out of the buck, etc. Actually, these only serve as slogans and don't help in coming to grips with the problem. We can state the formula mathematically in only two ways: 1. Optimum program equals X amount of dollars; 2. Y amount of program equals "Bogey" amount of dollars. I would like you gentlemen to consider this philosophy when you request your Radiac meters and various other equipments because you should understand that you are applying for your portion of the "Bogey". The first formula is a statement of requirement without regard to the dollar availability. The second is achieving a level of program a given amount of dollars. The first is useful to the extent it leads us to the establishment of a series of alternates which can be used in solving the second equation. In today's environment to conclude the problem at this point is at best very naive. In a Financial Plan cycle, when we are so close to implementation we must temper our requirements within the practical constraints of availability. There is probably no more significant problem posed to Commanders at every echelon than the objective and the responsible solution of the second equation. No one who has had to wrestle with this problem will minimize its importance or complexity. The trade-off point between quality and quantity becomes one of the most elusive problems. Fortunately, the specific decisions rendered as a result of the Financial Plan do not suffice for the entire year. The Air Force program is truely a very volatile and dynamic one and it has a daily effect on the Operations and Maintenance program. The quarterly revisions pose even more challenging problems because there is less time available, and little opportunity for any change in direction. In brief, you must adhere to the program which was so arduously prepared.

It is essential that we have a clear understanding of the approach taken by the Air Staff in accomplishing there review of the quarterly revisions. Of course, the only completely satisfactory solution would be to issue additional funds to

satisfy all unfunded requirements as rapidly as they are presented. To do this, however, would necessitate a huge reserve at Headquarters with accompanying contraction of the program. Obviously, this is not in the best interests of the Air Force. It is during the quarterly revision that the pain gets more acute and there is a tendency to build up pressures. Pressure is a strange phenomenon. Given the proper outlet and properly applied you can cut the problem down to size. This pressure built up amongst us has a tendency to accumulate and erupt with a destructive force. The pressures on the Operations-Maintenance Appropriations are real, gentlemen, not imaginary.

To enable all the commend echelons to devote the time and attention necessary to this very detailed and complex review area, working groups have been established and they are composed of a cross section of all the staff agencies at various echelons. No treatment of the Operations and Maintenance Appropriations would be complete without mention of the role played by these hardworking people. These people act as catalysts in gathering and accelerating the reaction by the senior staff committees in the resolution of the Operations-Maintenance fund problems. As a cross representation at a Headquarters Staff, this group isolates problem areas, major issues through painstaking evaluation and examination received from the detailed program in the financial plan that you gentlemen submit. This is the basis of this philosophy and you play an important part.

It would be inexcusable to omit from these remarks some explanation on limitations used in administering this medical budget program. These limitations are established in the medical program by us, in that we determine the phasing of the obligations, or the funds to be used in the financial plan. This monitary phasing is reported to Headquarters USAF and it represents the schedule for accomplishing our objectives for each quarter. The penalty involved for not meeting these objectives is the withdrawal of funds by higher headquarters, undoubtedly you've heard of this action many times. If I could revert back to the vernacular of the street "you have placed the money where it counts," i.e., you have taken a certain direction and now a change in the program is required. To obviate this penalty leads us to the discussion of how to retain the integrity of the Annual Financial Plan review and provide the necessary mobility to make these changes? A solution would be simply to apply the loosest definition of fund flexibility and proceed with complete disregard of the Annual Financial Plan reviews. Aside from the obvious damage of your credibility at higher headquarters, it has an additional disadvantage of reducing all previous monumental, painstaking efforts of the review to an exercise. This isn't the answer. The solution lies in the fact that a change, i.e., the additional funds for operation of your vehicle, TDY travel funds to take you to this symposium, has occurred in your initial program. All these requirements can be identified and measured when they are related to a known point. The Annual Financial Plan Review

process establishes this known point. Credibility is maintained and solidified when the change can be related to the previous approval. Fund flexibility is a means of affecting this change with maximum mobility, however, any changes that you make must be fully justified. Why? Because people in higher headquarters are asked these questions by review agencies. We must tell them why you have changed your program and why you couldn't continue as scheduled. We don't know this information unless it is included in the Financial Plan. It is in keeping with this principle that the quarterly revision to the Annual Financial Plan has been established.

The quarterly revision is a point in time when all the available funds have been distributed and the dynamics of the Operations and Maintenance Appropriations are such as to create a need for additional requirements. Contributing to the delimma is the fact that once the fiscal year is under way, there is a little chance for a change in direction, as I have explained in the foregoing. If the dynamics of the Operations and Maintenance Appropriations were all in the direction of increase, the only solution would be to have a huge reserve in the headquarters. Fortunately, this pattern doesn't manifest itself this way and such undesirable action is unnecessary. The pattern manifests itself in savings, accruing from slippages. What is a slippage? It is a programmed requirement which you defer for accomplishment at a later date. Fallouts, another budgetary vernacular of speech are programmed requirements which must be cancelled. It may have been management improvement which effected these monetary savings. The review of revisions would be simple if by some miracle all savings equaled requirements, and further, this miracle happened at each echelon. The reviews, however, are generally performed in an environment of significant deficits, therefore, only the highest priority requirements could be funded and requirements not meeting these high priority requirements will not be approved. I must re-emphasize what Colonel Sangster has pointed out to you in his presentation - justification will be required to be prepared by you because you are close to the problem. You, as the technician, know the problems; therefore; you must prepare this data for the Financial Plan so that you may further your mission.

In summary, the Financial Plan Revision process is not a means of applying pressure by resubmitting requirements on which a decision has been previously made, nor is it a non-realistic disregard for slippage which allows high priority items to go unfunded. The revisions are the means whereby the total Air Force can select the best series of alternatives in accommodating high priority items which were previously unprogrammed. Failure to maintain integrity in a revision points out to headquarters that perhaps the estimate was conceived on a basis of "guesstimate" and "snape decision". The discovery of fund excesses by reviewing authorities usually results in an arbitrary reduction which might cause a financial chaos within the estimating unit. The determination of a dollar requirement must be furnished. A budget estimate without

justification is, in fact, not a budget estimate but rather a mathematical summarization of figures. Without justification to explain the program's intent, the chances for receipt of your dollar requirements are very remote. It is well to understand that the budget estimate initially prepared at base level must pass the acid test of review authority. To be effective and complete, the statements must be in terms that a person with little or no medical background will understand. The inclusion of an item in your budget that cannot be explained places the entire estimate in jeopardy. Once the reviewing authorities find a cancerous element in the budget, this element casts a shadow of doubt on the remainder of the program. It is your responsibility, the individual with the particular requirement, to thoroughly review all requirements of the budget estimate prior to submission, weeding out all the portions that are questionable and assuring yourself that you can answer the following questions in the affirmative:

(1) Would I be willing to present this estimate to review agencies, including Congress?

(2) Would I approve this amount of money for this operation if I were reviewing it?

Once the reviews are completed within the Executive Department of the President there remains a necessity to backup material and searching reviews by the Appropriations Committee of Congress. While we don't subscribe to a theory of accumulating information "just in case" basis, there is a necessity to be prepared for any kind of question by Congress. The Congressional Committee members in the conscientious exercise of their trust will ask questions which will run the gamot. Without the benefit of this material submitted by the field, the authorities would be incapable of complying with the requests made for information during the various stages of review. Based on these facts just stated, we can say that the budget estimate as submitted by the field is a very useful document, indeed, and it is worthy of all the time, effort and patience that is devoted to its compilation. Without it, we could not nearly be as effective in defending the Air Force medical requirements.

STAFFING AND MANPOWER

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I am honored to have been invited to participate in this symposium. The difficult problems associated in developing an ideal Air Force Sanitary and Industrial Hygiene Engineer personnel structure and program are well known to those of us in the Air Training Command whose motto is "Prepare the Man". My two most recent four (4) year Washington tours in Medical Personnel Utilization and Career Control acquainted me with the complexity of personnel and utilization requirements for your group. I left the Surgeon General's Office approximately a year ago. However, the Directorate of Staffing and Education in the SGO has generously furnished updating material covering this past year. In the brief time allotted, I should like to discuss some of the more significant aspects of staffing and manpower in your field. I will do this by briefly discussing four (4) main points:

1. The increasing manning requirement for engineers.
2. The procurement program.
3. The experience level of those on board, and
4. Problems associated with career development.

In discussing the manning requirement for Sanitary and Industrial Hygiene Engineers, one fact stands out--that is, the ever changing and increasing complexity of the USAF environment has resulted in manning requirements for an increased number of engineers each year and the trend will continue. There exists a need for participation of engineers with biomedical training in many new areas of application as well as in amplification of the more conventional environmental health and industrial hygiene practices. Number-wise, I am told the Air Force will be in fairly good shape for another year. A quick recap of the authorized positions by grade show:

Grade	Authorized		Assigned As of 1 Sep 62
Col	4	2.5%	5
Lt Col	6	3.7%	7
Maj	25	15.3%	6
Capt	48	29.4%	14
Lt	80	49.1%	125
	163		157

Later we will look in more detail at the wise disparity in the grade structure for engineers assigned as compared to the overall Air Force grade spread.

The next point centers around the means by which Sanitary and Industrial Hygiene Engineers are obtained to fill authorized positions. During the past few years, the primary scource of procurement has been through AFROTC. Direct appointments from civilian sources supplies only a small per cent of the requirement each year. The majority of those applying for direct appointment have graduate degrees with public health or sanitary engineer majors.

For several years attempts have been made to encourage senior college students to participate in the Sanitary and Industrial Hygiene Engineering phase of the Medical Allied Science Training Program. However, this has not been successful. In 1959, a quota was established for eight (8) airman students annually in the Airmen Education and Commissioning Program specifically for Sanitary and Industrial Hygiene Engineering degrees. Again, this has not met with much success. Only six (6) airmen have enrolled in this program in the past three fiscal years. Information obtained from AFIT reveals that most airmen who have inquired about this training program gain the impression they will be nothing but "latrine inspectors". The deletion of the word "sanitary" in the AFSC title may serve to minimize this misunderstanding.

Since 1957, the Medical Service has had a quota of at least 15 Sanitary and Industrial Hygiene Engineer students established as a levy against the total AFROTC annual input. To date not more than two or three have actually enrolled in the advanced training phase of AFROTC against this requirement. This may be due to a lack of encouragement by Professors of Air Science or to a lack of knowledge on the part of the PAS as to the actual function of a Sanitary and Industrial Hygiene Engineer. To my knowledge AFM 36-1 is about all the PAS has for descriptive material on the duties of the Sanitary and Industrial Hygiene Engineer. It is not a very glamorous or accurate description and requires updating and elaboration.

In looking at the overall procurement program, we find the Medical Service was fortunate to get sufficient AFROTC graduates to meet the annual requirements during FY-60, 61 and 62. However, the FY 63 production within the AFROTC is expected to fall short of the desired goal and in turn the Medical Service procurement of Sanitary and Industrial Hygiene Engineers will fall short by at least one fourth.

My third point deals with the experience level of the Sanitary and Industrial Hygiene Engineers we now have in the Air Force. I think the most startling statistic is that 80 per cent of Medical Service engineers are Lieutenants who have less than five years experience. This figure compares with 28

per cent for the total Air Force officer structure. As we go up the ladder the figures invert:

Grade	911 and 912 Assigned	AF Total Assigned
Col/Gen	3%	4%
Lt Col	4%	11%
Maj	4%	19%
Capt	9%	38%
Lt	80%	28%

Some progress is being made in retaining the Sanitary and Industrial Hygiene Engineer in the Air Force beyond the minimum time required to serve. At present there are 74 Regular and Career Reserve Officers on active duty. One of the motivating factors in increasing this number is the availability of additional training under the auspices of the Air Force. There are 13 to 15 Sanitary and Industrial Hygiene Engineers in the institute of Technology each year, which is quite a high ratio to the career field total population. Only time will tell whether or not the training of this high ratio of engineers will result in a more stabilized officer structure in this career field.

The fourth point I would like to touch on deals with problems associated with career development of the Sanitary and Industrial Hygiene Engineer. It is probable that the majority of engineers in the Medical Service are assigned duties and responsibilities beyond their military grade and experience. This simply is a result of the supply and demand problems discussed previously. This subject gets a bit more confused on the education side of the house. For instance, 7 of the 13 who have been approved for Institute of Technology training this year will be in Nuclear Health Physicis. Sanitary Engineering and Health Physics are admittedly compatible specialties but the fact remains they are separate specialties under AFM 36-1 (Officers Classification Manual). As the graduates migrate, the retention and career development pattern often becomes clouded and confused. Some, who have been so trained, wear two hats; some use this training to augment their background in engineering, while still others become hyper specialists in a number of areas depending, in many instances, on where and in what capacity they are assigned upon graduation.

Another problem in career development is the continuing necessity for lateral moves. Ideally, each reassignment should be a step up to a more important job. This is fine and good and generally summarizes the whole of the career development concept. However, lateral moves are obviously almost unavoidable when working with such a small manpower resource

and the turnover is so great. Also, I can state with some experience, that it is a matter of individual judgment and open to debate as to which jobs are the most important or which is the most difficult.

Two other subjects crop up with some regularity when discussing retention and the development of a more attractive Sanitary and Industrial Hygiene Engineer career field. One is special pay and the other --establishment of a Sanitarian career field.

At present the outlook for special pay in the near future for Medical Service Engineers and Allied Scientists does not appear likely. The chances for special pay may improve if the proposals could be included with those originating in the Air Force Systems Command for researchers and other scientists. To be realistic, however, the lawyers and Systems Command have not had much success with their proposals.

So far as the Sanitarian is concerned, the basic problem seems to be--although he can be used at base level, what progression pattern would he follow after reaching the grade of Captain or Major? The problem of obtaining UMD authorizations at the expense of other critical career fields complicates this further. Many feel that a better solution might be to improve the technical competence and use of the Preventive Medicine Technician, 907X0. Of course to improve the competence of the technician requires the establishment of/or enlarging the training facilities either at Gunter or at civilian institutions. Also, this training would necessarily be restricted to highly qualified and motivated personnel.

Time does not permit a more detailed discussion of the airmen picture. A shortage exists at the "7" level although we are over total wise.

Airmen, AFSC 907x0, Authorized and Assigned as of 1 September 1962

Level	Authorized	Assigned
90730	100	94
90750	335	423
90770	199	138
90790	6	5
	640	660

In this rather general discussion, I have attempted to cover a complex area which is of interest to all of us. In summarizing , (1) we find the requirement for Sanitary and Industrial Hygiene Engineer personnel increasing to keep pace with the complexity of the Air Force environment. (2) The procurement of engineers to fill this rapidly expanding requirement may fall 25 per cent short in FY 63. (3) The military experience

level of the larger segment of engineers in the Medical Service is far below that in the overall Air Force officer structure which is due to the past high attrition in the engineer field. (4) The career progression of the engineer in the Medical Service is compromised to some extent by the necessity for lateral moves and a trend toward increased specialization.

In spite of these problems which are not entirely peculiar to your group, opportunities are unlimited for continued and even increased recognition of the value of your contributions to the Air Force. The almost 90 per cent who are serving as Lieutenants and Captains and those in higher grades have a most attractive future in the military.

Thank you gentlemen for your attention.

INTERPRETATION OF ANALYTICAL RESULTS OBTAINED FROM BIOLOGICAL MATERIALS

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Two of the most important, practical questions which confront the industrial hygienist and the physician who wish to protect the worker from injury as a result of exposure to harmful agents are:

1. What is the toxic hazard associated with a given chemical or physical agent?

2. Are there methods available which will permit detection of early toxic effects? (1)

By definition, a toxic substance is one which possesses certain inherent, harmful properties which may destroy life or endanger health. (1) This inherent property is the "toxicity" of the material.

Virtually every known chemical possesses the inherent ability to destroy life or endanger health, provided that the does is sufficiently large. "The question is not whether a material is potentially harmful, but how much must get into the body before harm results." (1) It must be remembered that regardless of how toxic a substance is, no damage occurs, unless the material gains entry into a biological system.

Thus, there are three factors which must be considered before one can arrive a proper estimate of toxicity in any given situation. (1)

a. "Inherent potential to destroy life or impair health

b. Dose

c. Exposure"

In the interpretation of the results of analyses on biological samples, one must remember that:

a. The presence of a toxic substance in biological material indicates exposure and absorption but not necessarily intoxication.

b. It is essential to know the concentration of the toxic material not merely its presence or absence. Thus samples which are not suitable for quantitative analysis are usually of little value.

c. Relatively few industrial poisons produce diseases resulting in specific laboratory findings.

d. After removal from exposure, many if not most, toxic gases and vapors are eliminated rapidly by the lungs so that none or only small amounts remain in the body a few hours or a day after exposure ceases.

e. Many toxic materials undergo matabolic change and may appear in biological fluids as one or more metabolities with or without a fraction of the original substance. (2)

f. The worker himself is actually a sampling device and the analysis of body fluids may be directly related to the atmospheric concentrations if due regard is given to routes of excretion, excretion rates and metabolic changes provided that suitable analytical methods are available for estimation of the concentration of the material in biological samples.

g. Generally speaking, analysis of biological samples is technically more difficult than the same analysis of an environmental sample; e.g., air or water. However, it is frequently more revealing.

h. Exposure with absorption of a material may be non-occupational in nature; it may occur at home as a result of "outside" work, hobbies, diet, medication, etc.

i. "The concentration of a toxic metal in the blood is more likely to be correlated with symptoms and signs of poisoning than the quantity or concentration in the urine." (2)

The "Matching Process", as advocated by Johnstone and Miller (2) and many others, should always be employed in the evaluation of any alleged "occupational poisoning". Application of the "Matching Process" requires that one adhere carefully to the"Laws of Specificity". (2) The laws are as follows:

1. Is the suspected substance known to have toxic properties in the probable concentration under consideration?

2. Has the reaction (of the patient) in the case under study conformed to known, established reactions?

3. Does the suspected substance exist in a chemical and physical form so that it can be absorbed into a biological system?

4. If so, what organ or organ systems is it known to affect?

5. Has an undue exposure actually occurred?

6. Are the laboratory data confirmatory of absorption, intoxication and systemic injury? (2)

Use of this procedure eliminates the all-to-frequently employed technique or "jumping at conclusions". The latter almost insures diagnostic errors as a result of failure to investigate the nature of the occupational environment and to identify a specific etiological-chemical or physical - agent.

Thus far in 1962 the number of samples submitted for urine, blood and water fluoride analyses has increased approximately 5 fold over the entire year 1961. The number of samples is not great but the increase in number is of interest as are the requests for information which frequently accompany these samples.

A brief discussion of fluoride estimation in water, urine and blood seems to be in order because of certain peculiarities in the metabolism of fluorine compounds. This will also serve to illustrate certain considerations relative to the proper interpretation of the analytical results of other materials in biological fluids.

Examples of the type of information frequently requested are as follows:

a. "During the past few months it has been observed that a higher percentage of personnel included in the occupational health program have been found to have increased urinary fluoride levels".

b. "Do you place any significance upon the fact that base water supplies are being fluoridated more today than in the past?"

c. "Would a high normal value be expected in a person who routinely consumes fluoridated water?"

d. "What does your laboratory consider a normal value for urinary and blood fluoride levels?"

e. "What increase would be expected due to an occupational exposure?"

f. "What is a normal blood fluoride level for employees assigned to the water fluoridation unit where dry fluoride powder is added to the base domestic water supply?"

Any consideration of these questions requires data as to the "normal"

or "usual" range of fluoride in blood and urine and the geographic areas where these determinations were made. More important are data as to the "usual" range of blood and urine fluoride in the geographic area under consideration, fluoride concentration in domestic water supply, occupational exposures - if any solubilities of different compounds, diet of the population, age groupings of the population, elapsed time since the last known, significant exposure, etc.

Machle (3) reported urine fluoride levels for 101 adult subjects at various locations in the United States and Canada and for 38 hospitalized women and children. The range was 0.56-2.80 mg./l; the mean value was 1.07 mg./l. Machle and Evans (4) reported on exposures of workers in foundries; the mean fluoride urine concentration was 3.65$\pm$ 0.54 mg/l. In 4 out of 38 of these adult males, urine fluoride levels ranged from 16 to 23.9 mg./l. They reported no evidence of injury, clinically or by x-ray, after 5 years of exposure. (However, it is quite certain that significant storage of fluoride was occurring in these workers.)

Largent (5) reported essentially similar findings among three groups of employees; the urine fluoride concentration was directly related to the degree of occupational exposure.

Urine fluoride concentrations as high as 43.41 mg./l. among cryolite workers were reported by Brun, et. al. (6) There was clinical and x-ray evidence of storage and impared health. In some cases the urine fluoride levels remained as high as 7.42 mg./l. after 11 years freedom from further occupational exposures. After skeletal storage of fluoride has occurred, excretion continues for prolonged periods of time.

Collings, et. al., (8) have shown that under the usual industrial working conditions involving exposures ranging from 3.3 to 5 mg./ cu. m. of air of 8 hours duration followed by 16 hours of freedom from exposure the urine concentration will return to, or near to, the pre-exposure level. This factor must be considered in the interpretation of urine and blood fluoride levels as well for the urine and blood concentrations of certain other chemical compounds.

With respect to fluoridation of domestic water supplies using dry chemicals, Zufelt (7) reported air concentrations of fluoride of 8.80 mg/cu.m. of air near the hopper. However, filling the hopper required only 5 min. per shift. All urine samples from employees were well below the "safe level" with a range of 0.10 to 1.58 mg./l. or urine with a mean of 0.72 mg/l. This offers a good example of the importance of the duration of exposure.

In regard to the increase of urine fluoride concentration as a result of fluoridation of domestic water supplies, Smith, et. al., (9), showed that when the fluoride concentration of water was increased from 0.06 to 1.36 ppm (23 fold increase) mean urinary fluoride increased from 0.06 to 1.12 ppm (19 fold increase.) However, the mean blood fluoride increased from 0.014 to only 0.040 ppm (3 fold increase).

Age is also important with respect to the increase in urine fluoride after changes in exposure, including fluoridation of water supplies. In children ages 5 - 14 years, 3 to 5 years will elapse before the urine fluoride level approximates that in the water consumed. However, in adults 30 - 39 years of age the urine fluoride level will approach that of the water consumed in 1 to 6 weeks after the fluoride content of the water is increased. (10)

Finally, with respect to urine fluoride levels, it is generally considered that the tentative, "limiting safe" value is about 4 mg./l. of urine. (11)

The analysis of whole blood for fluoride is technically difficult, time consuming and expensive. Wulle (12) reported on the analysis of 105 samples of adult human blood with a range of 35 to 105 ug./100 grams of whole blood. In general, in the United States where environmental fluoride is not excessive and where there is no undue occupational exposure to fluorides, the blood fluoride concentration will average less than 20 ug./100 grams of whole blood and usually less than 15 ug./100 grams of blood. (13)

Fluoride disappears very rapidly from the blood. Approximately 84 - 86% of a known dose of sodium fluoride has been removed from the blood within 1.5 to 2 min. after injection. (13) Wallace Durbin (14), using F^{18}, demonstrated similar, rapid disappearance of injected fluoride from the blood of rats. Thus, any interpretation of blood concentrations must be made with extreme care. In general, the blood fluoride level is not significantly revealing in cases of occupational exposures.

As noted previously, "The concentration of a toxic metal in the blood is more likely to be correlated with symptoms and signs of poisoning than the quantity or concentration in the urine." (2)

There is notable exception to the above statement. This exception should be of particular concern and interest to Air Force industrial hygiene engineers. The determination of lead in blood in an attempt to evaluate the degree of absorption of tetraethyl lead, and other lead alkyls, probably, is futile. The concentration of these compounds in

the blood virtually no relationship to absorption, distribution in the tissues or the condition of the patient. (15)

The industrial hygiene engineer must play a significant role in the evaluation of the analytical results from biological materials if such results are to be properly interpreted. He can supply essential information as to the specific etiological agent, the chemical composition and physical state of the material, the concentration of the agent in the environment, and the duration of exposure. In the absence of such data, proper interpretation of analytical results by the physician is at best difficult and, in fact, may be impossible.

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COMBUSTION AND DEGRADATION PRODUCTS OF N_2O_4 AND UDMH-HYDRAZINE MIXTURES

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In the ever-expanding missile and space vehicle fields, two items are to the forefront in the mind of the Systems Engineer. These are: specific impulse and fail-safe operation.

Of the various storeable liquid propellants, none in common use give higher specific impulse than the hydronitrogens; hence, these are in large supply at present and their procurement increases daily.

In insuring fail-safe operation, the engineers' desires are most nearly met by the use of hypergolic fuels, (i.e., those which ignite on contact with an oxidizer), which eliminates the need for a complex ignition system with its concomitant weight penalty and inevitable operational failures.

Again, the hydronitrogens are most desirable from an operational standpoint, since they are hypergolic with almost every oxidizer one can think of, including WFNA, RFNA, hydrogen peroxide and N_2O_4.

The following remarks are mainly concerned with the Titan II System, which employs a nominal 50-50 mixture of hydrazine and UDMH as fuel, and liquid N_2O_4 as oxidizer; however, these cannot be considered as restricted to the Titan II, since many other systems use one or more components of this mixture as well. (Table 1). (See next page).

As can plainly be seen, the engineers are quite pleased with the mixture as indicated, and numerous variations thereof.

Unfortunately, nothing is perfect in this world; while it would be most desirable that a third criterion - safety - be met, it is quite obvious that in missile system components, safety comes in a poor third, if at all.

It is necessary, then, since missile crews are definitely non-expendable, that safety be engineered into the program.

Before a problem can be solved, however, it is first necessary that one have some idea of what the problem is. It has been well known for many years that hydrazine, UDMH and N_2O_4 are corrosive, irritating, and toxic; however, their chemistry is complex and exotic and is not likely to be solved in any simple fashion for a long time to come.

TABLE I

Missile Systems Using Amines

Vehicle	Manufacturer	Oxidizer	Fuel	Payload
ABLE	Aerojet	IWFNA	UDMH	Tiros I, Pioneer I, II, Explorer VI
ABLE STAR	Aerojet	IRFNA Isp=248	UDMH	Transit 1B, 2A, 3B, 4A, 4B, GREB I, II, Courier IB. LOFTI, INJUN, FRAAC
DELTA	Aerojet	IWFNA IRFNA	UDMH UDMH	Echo I Tiros II, III, IV, Explorer X, XII, OSO
VANGUARD	Aerojet	IWFNA	UDMH	Vanguard I, II, III
ATLAS-ABLE	Space Tech. Laboratories	N_2O_4 Igniter	N_2H_4 (Mono)	Vernier
AGENA A	Bell	IRFNA	UDMH	Discoverer I
AGENA B BA-5 Series	Bell	IRFNA	UDMH	Discoverer II, V-VIII, XI, XIII, XIV, Midas II, Samos II
BA-7 Series				Discoverer XVII-XXI, XXIII, XXV, XXVI, XXIX-XXXII, XXXIV-XXXVI, XXXVIII et seq. Midas III, IV Ranger I-A, II, III
AEROBEE 100	Aerojet	IRFNA	UDMH	Research Vehicles
L A R	Naval Ord. Test. Sta.	IRFNA	UDMH	Warhead
BOMARC	Aerojet	IRFNA	*JP-X	Warhead
NA-2	Rocketdyne	IRFNA	*Hydyne	Target Drone
TITAN II	Aerojet	N_2O_4 Isp= 259	*Aerozine-50	Warhead; Manned Vehicles

*JP-X; Gasoline -UDMH mixture
*Hydyne; 60% UDMH; 40% Diethylenetriamine (R) Rocketdyne
*Aerozine-50; 50% Hydrazine, 50% UDMH (R) Aerojet-General

Our efforts have been, not to find all the possible products of these mixtures, but rather to determine the most likely substances to be produced under two sets of conditions definable as routine and non-routine, and the most likely environm ental effects of these products on humans, plants, animals, soil, and water.

Extensive investigations are being performed on these parameters at McClellen, Wright-Patterson, and other Air Force installations, at various contractor sites, and at many universities throughout the country in an effort to define the hazards and devise effective methods of eliminating them.

The criteria are these:

(1) Routine: Any actual mission-firing of a Titan II or other missile using the indicated mixtures.

(2) Non-routine: Any spill, in the silo or exterior, or any or all of the components of the system.

In routine firing, the main components of the cloud are:

Water
Carbon Dioxide
Carbon Monoxide
Nitrogen

Lesser Components: NO_2, N_2H_4.

The leading edge of the could contains considerable NO_2, as would be expected, since in hypergolic ignition the oxidizer is introduced into the nozzle first.

It is rather astounding, but worthy of note, that hydrazine and NO_2 coexist in the cloud; since they are hypergolic, it would be expected that they would be mutually destructive and that one or the other might exist, but not both. Experiments, however, have shown that while hydrazine and NO_2 do react in the vapor phase, the reaction is slow, requiring hours for completion. Data to this point, however, indicate that UDMH is not present in the cloud or, if present, is in less-than-detectable quantity.

The general environmental hazards occasioned by an actual firing may be divided into two distinct areas:

(1) Gaseous products

(2) Liquid products

The main gaseous product of any concern is Carbon Monoxide, an insidious killer which, being nearly the same specific gravity as air, remains in solution and in place for some time. While nitrogen is not to be considered as hazardous by itself, it may displace or dilute the air normally present to such an extent that anoxia would result from breathing the mixture, even if carbon monoxide were absent. Carbon dioxide in high concentration presents a typical syndrome characterized by hyperventilation and panic, which is always dangerous. In short, the cloud itself is no place to be, which might be considered as belaboring the obvious. Less obvious, however, is the fact that this same atmosphere will be present in an underground location for considerable time after an actual firing.

Elementry precautions must be taken when entering an enclosed structure from which any missile has been fired; the atmosphere should be monitored for carbon monoxide, carbon dioxide, and oxygen, as well as for the system components themselves.

Water vapor, of course, presents no hazard; and, under normal conditions, no one would enter a structure until the residual hydrazine and NO_2 had either reacted or escaped. If it became necessary to enter a missile silo immediately after a firing or because of some malfunction, it is to be presumed that protective clothing, including self-contained air supply, would be provided.

The major environmental hazards would result, then, from spillage of the missile fuel and/or oxidant either in the silo or on the ground. There is also the possibility of spillage from leaks in the pipelines. In all of these cases the hazards are due primarily to reaction with the soil or on the surface of soil granules, to form a wide and varied assortment of degradation products, some or all of which may be toxic. These may enter surface or ground water supplies to the detriment of vegetation or the human or animal population of an area.

N_2O_4, of and by itself, is of little moment. It reacts almost instantly with the acid-fixing moiety of the soil, forming nitrates and nitrites which are beneficial to nearly every type of vegetation. The only requisite is sufficient dilution so that the soil pH is not lowered so drastically as to kill vegetation. N_2O_4 and its solutions should not, however, be allowed to drain into surface or ground water supplies, since nitrate as low as 10 ppm may cause methemoglobinemia in infants, and nitrite should in no case exceed 2 ppm.

UDMH and Hydrazine, however, with or without N_2O_4 cause a more severe problem. They are not only toxic in themselves, but many of their degradation products are also toxic; hence, it is not sufficient merely to destroy the hydrazine and UDMH: solutions resulting from their reaction with soil, air and water must be brought within tolerance limits of every degradation product; this may be a large order. (Table II)

TABLE II

Toxicities and Limits known breakdown products of the system N_2O_4 - UDMH, N_2H_4

Substance	Human	Plant	Animal	MAC (ppm)
UDMH	I, A, L(?)	F, P	I, A	0.5
N_2H_4	I, A, L(?)	F, P	I, A	1
NH_3	I	F, P	I	100
N_2O_4	I, L, K, B	F, P	I, L, K, B	5
$(CH_3)_2NH$	I, L, K, A	- -	I, L, K, A	
CH_3NH_2	I, L, K, A	- -	I, L, K, A	
HCHO	I	- -	I	5
HCN	A, B	- -	A, B	10
HCNO	A	- -	A	10
CO_2	A	- -	A	5,000
CO	A, B	- -	A, B	100

A - Asphyxiation
B - Blood Cell damage or alteration
F - Fertilizer in low concentration
I - Irritant to skin, mucous membranes, and organs
K - Kidney damage
L - Liver damage
P - Poisonous in high concentration

After a recent spill, in which some three gallons of UDMH-hydrazine mixture was dumped and diluted with water, after six weeks' elapsed time, UDMH and hydrazine were still present, as were formaldehyde and hydrogen cyanide. Even after neutralization and oxidation with hydrogen peroxide, while the concentrations of UDMH and hydrazine had been reduced effectively to zero, the concentration of formaldehyde was still high. The point here is, that even though it is possible to remove UDMH and hydrazine by oxidation, the by-products may be as offensive as the compounds themselves. Suppose, for a moment, that instead of three gallons, the spill had been three hundred gallons -- or three thousand!

As an example of what might happen, a pipeline in North Africa some five years ago sprung a leak. Before anyone realized what was happening some three thousand gallons of JP-4 fuel were lost into the soil. Such a spill might appear to be a minor matter; the soil can hold a lot of petroleum. The trouble was that seventeen wells were being pumped free of fuel -- a process which took about six weeks. There was also a matter of damage to plants and livestock to be taken care of. It is unfortunate, but true, that the poorest range steer becomes a prized herd bull the instant that he is killed by anyone's accident. The Air Force, an industrial concern, or a private individual, pays top prices for animals killed in this fashion.

For vegetation, the price is what the traffic will bear, particularly if the soil is poisoned for more than the length of the growing season.

Fortunately, the Jet Fuel did not injure any people; it merely made the water undrinkable for six weeks. Had any components of the Titan II system been spilled, however, a cause célèbre would undoubtedly have resulted, as it would in this country. It cannot be too strongly stressed that these compounds and their degradation products are poisonous until they have finally been oxidized to nitrates, CO_2 and water.

While, from an industrial hygiene standpoint, it might be pleasant to say, "Spills will not occur", it is best to legislate against the inevitable, and to be prepared against the spills which will occur, understanding that without extensive - and expensive - neutralization, UDMH, hydrazine and N_2O_4 may not be allowed to enter surface water, or ground water aquifers. One exception may be noted; the ocean is a reservoir of essentially infinite capacity. Many such compounds may be eliminated by barrelling, weighting, and dumping into the ocean past the continental shelf, provided this is not otherwise prohibited. For installations close to the coast, this means may be best. For others, the minimum safety procedures require site selection such that no waste products will enter drinking or irrigation water supplies; failing this requirement, complete treatment facilities and acres of concrete are necessary.

For guidance in this matter, it must be remembered that various state water pollution control boards have decreed that no effluent of any industrial process may raise the receiving water above the maximum permissible concentration for any component; therefore, when UDMH and hydrogen cyanide are the items under consideration, the only criterion possible is complete destruction. Fortunately, hydrogen peroxide and time will eliminate both.

Experiments are currently under way to refine the conditions under which these compounds may be completely eliminated in less time. Catalytic decomposition seems to give some promise, but the results are not all in yet. It seems definite, however, that holding ponds are going to be a must, in order to legislate against the maximum credible accident.

Let us hope that it never occurs, but let us be prepared for it if it ever does.

PEP - PERT MEDICAL CONTRIBUTIONS

Colonel John Boysen, MC
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In a recent article (1) it was written that "It is only a matter of time .... before all major defense and research and development contractors for the government are involved in PERT on a mandatory basis". The author goes on to predict that much wider applications will follow in other industries - that it is now taught at the Harvard Business School - that a 5-day course costs $130 and is playing to full houses.

PERT, PEP, CPM What's it all about? Basically, these management techniques are similar. They are devices employed to aid a manager in determining exactly what must be done, who should do it and when, where and program stands at any specific time, and what obstacles are to be faced and overcome in the future.

You are probably asking the meaning of these symbols? Here they are:

PERT - Program Evaluation and Review Technique
PEP - Program Evaluation Procedure
CPM - Critical Path Method

PERT was developed primarily by the U.S. Navy and was largely responsible for getting Polaris missiles in service some three years ahead of schedule. PEP is a U.S. Air Force adaptation particularly useful where priority and resources are not continuously varying. CPM, and there are other modifications, is a civilian counterpart, deriving its name from a feature of the other systems.

For many years we have had many techniques of management from simple check lists, to time-phased project charts, and milestone techniques to mention a few, but all of these had the short-comings of the lack of sequential timing of events necessary to meet target dates. These older methods were largely manual and poorly adapted to large complex projects where a manager cannot possibly look at all elements of a program and make logical decisions involving re-allocation of resources. With the use

1. Simons, Howard, "PERT: How to Meet a Deadline" Think (Published by IBM) 28: No. 5, p 13-17, May 1962

of statistical techniques including computer applications the manager is now able to explore alternate solutions and thereby take corrective actions necessary to maintain a schedule. There are six basic steps in setting up a PERT or PEP system:

a. Select and define each EVENT
b. Establish a NETWORK
c. Place a time value on each ACTIVITY
d. Compute EXPECTED TIME (te)

$$te = \frac{a+4m+b}{6}$$

where a = optimistic time
m = most likely time
b = pessimistic time

e. Determine CRITICAL PATH
f. Devise a REPORT CARD in form of a standard print-out that focuses management s attention on problem areas.

For a moment - let me define some of these terms as they appear on Chart 1[2]I previously stated that the first step was to select and define each event. In Chart 2 you will recognize a simplified list of events necessary for the construction of an aircraft. It could just as well have been for the development of a monitoring instrument used in industrial hygiene, or an SOP for a medical facility, based upon toxicological research, clinical investigations, and subsequent experiences with therapeutic techniques. The important point that you recognize is that these are Events, they do not consume time or resources and they are recognizable at a given instant of time. It is frequently easier to began the listing of events by starting with the end objective and proceeding backward in time, asking yourself "what will I need to get to this point?"

The second step is to establish a NETWORK. This is a flow chart which establishes the sequence and inter-dependency between events (Chart 3). Each event is numbered and titled. Arrows representing Activities leading up to each event sequentially link the events. These arrows represent the physical or intellectual work necessary to complete the activity.

The third step is to place a time value on each activity. Actually three values are used: Optimistic, most likely, and pessimistic. These are generally expressed in weeks, although any uniform unit may be used.

2. All charts are from "PEP" published by Plans and Program Office of Directorate of Systems Management WADD, (February 1961)

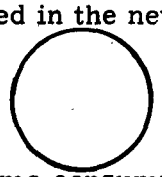
CHART 1

NETWORKS

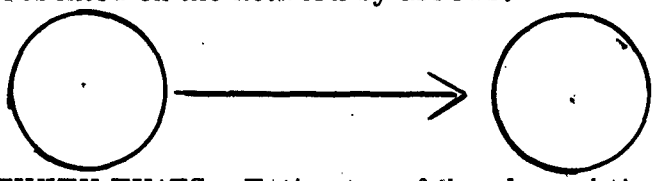
A Diagrammatic Representation of the Program Plan That Shows the Sequence and Inter-relationship of significant finite events (Progress Benchmarks) in the Plan to Achieve End Objectives Under Planned Resource Applications and Performance Specifications (Similar to a Radio Schematic)

Consist of EVENTS and ACTIVITIES

EVENTS - A meaningful specified accomplishment (Physical or Intellectual) in the Program Plan, recognizable as a particular instant in time. Do not consume time or resources. Represented in the network by circles.



ACTIVITIES - The time consuming element of the program. An event is separated from other events by activities. Represented on the network by arrows.



ACTIVITY TIMES - Estimates of the elapsed time in weeks necessary to complete an activity in a specified manner. Recognizing the uncertainty inherent in development, a range of times is specified by:

Optimistic Times
Most Likely Times
Pessimistic Times

CHART 2

ESTABLISHING A NETWORK

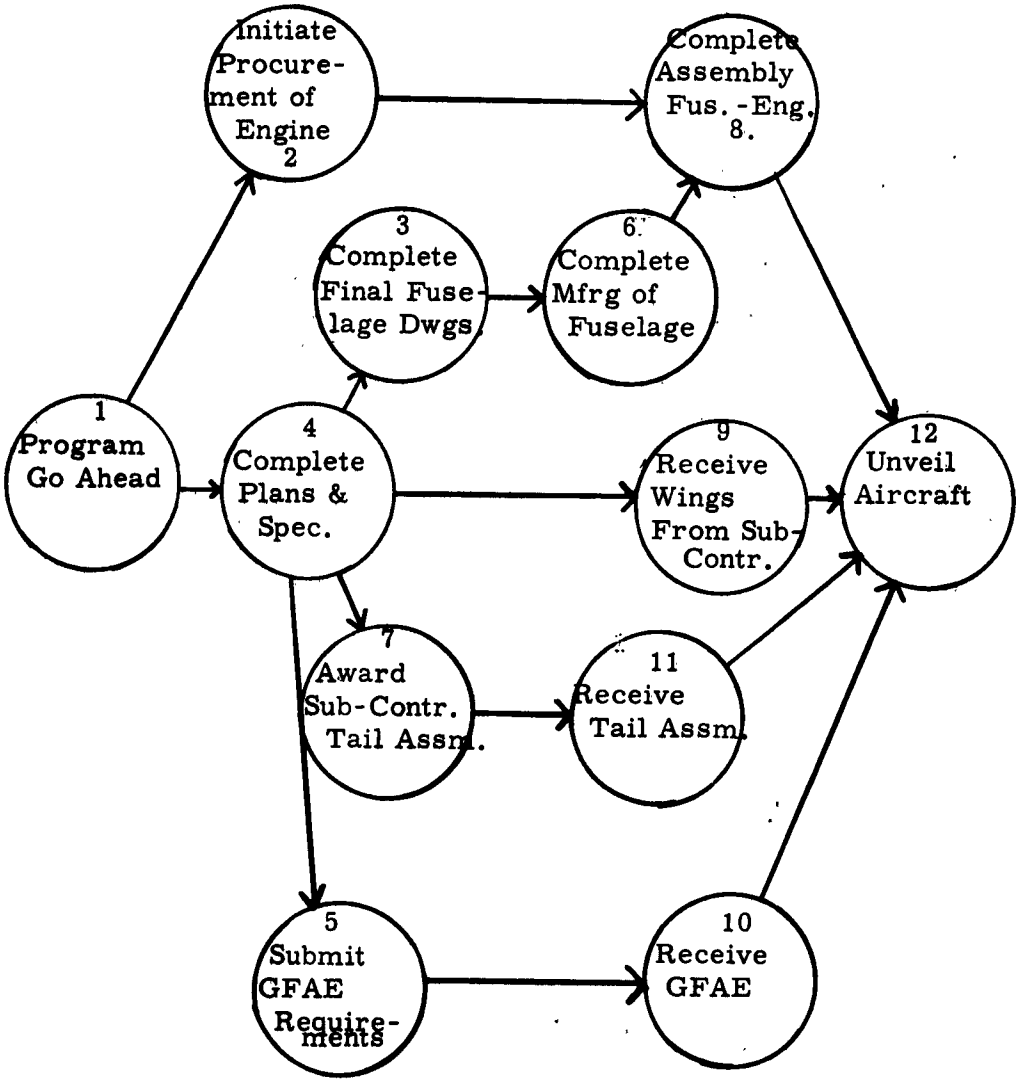
Task is to build an aircraft

Key Events are:

1. Program Go Ahead
2. Initiate Procurement of Engine
3. Complete Final Fuselage Drawings
4. Complete Plans and Specs
5. Submit GFAE Requirements
6. Complete Manufacture of Fuselage
7. Award Subcontract for Tail Assembly
8. Complete Assembly Fuselage -Engine
9. Receive Wings from Subcontractor
10. Receive GFAE
11. Receive Tail Assembly
12. Unveil Aircraft

CHART 3

EVENTS - ACTIVITIES



The computer will be programmed to print out dates, when it "knows" the starting date! (Chart 4)

The fourth step is to compute the "expected time" of each activity (Chart 5). If one were now to add up each "expected time" along each pathway from the start to completion, he would find one pathway to be the longest. This is the Critical Path, which means any delay of any activity will delay the completion of the end objective, unless readjustments of resources are made. In highly complex networks, all of these possibilities are explored with the use of computers so that the manager can make reasonable "trade-off" decisions.

Print-outs are produced periodically for management purposes. These are based upon progress reports from each of the organizational elements responsible for each activity. This provides the opportunity for up-dating and keeping the network current at all times. The details of the sophisticated computer and statistical techniques employed are subjects beyond the scope of this paper. My primary purpose in presenting this material is two-fold; first, you will undoubtedly be involved sooner or later in one or more of these networks as a part of the development of some systems, and, second, the use of the simple diagraming procedure I have just described is a useful tool for many of your projects, which require a significant number of inter-related events. It can be an aid in self-discipline in establishing an orderly progression of events, properly timed, and adequately documented. Think of it for making all the arrangements - all interrelated --for a symposium such as this, or for a wedding. In many respects we use the same basic technique "in our heads", for many of our projects. This network, in its simplest form, is merely an easily understandable diagram of "who is supposed to do what to whom and who is going to pay for it", and the beauty of it is that once it is published everyone knows it!

CHART 4

EVENTS - ACTIVITIES - TIME ESTIMATES

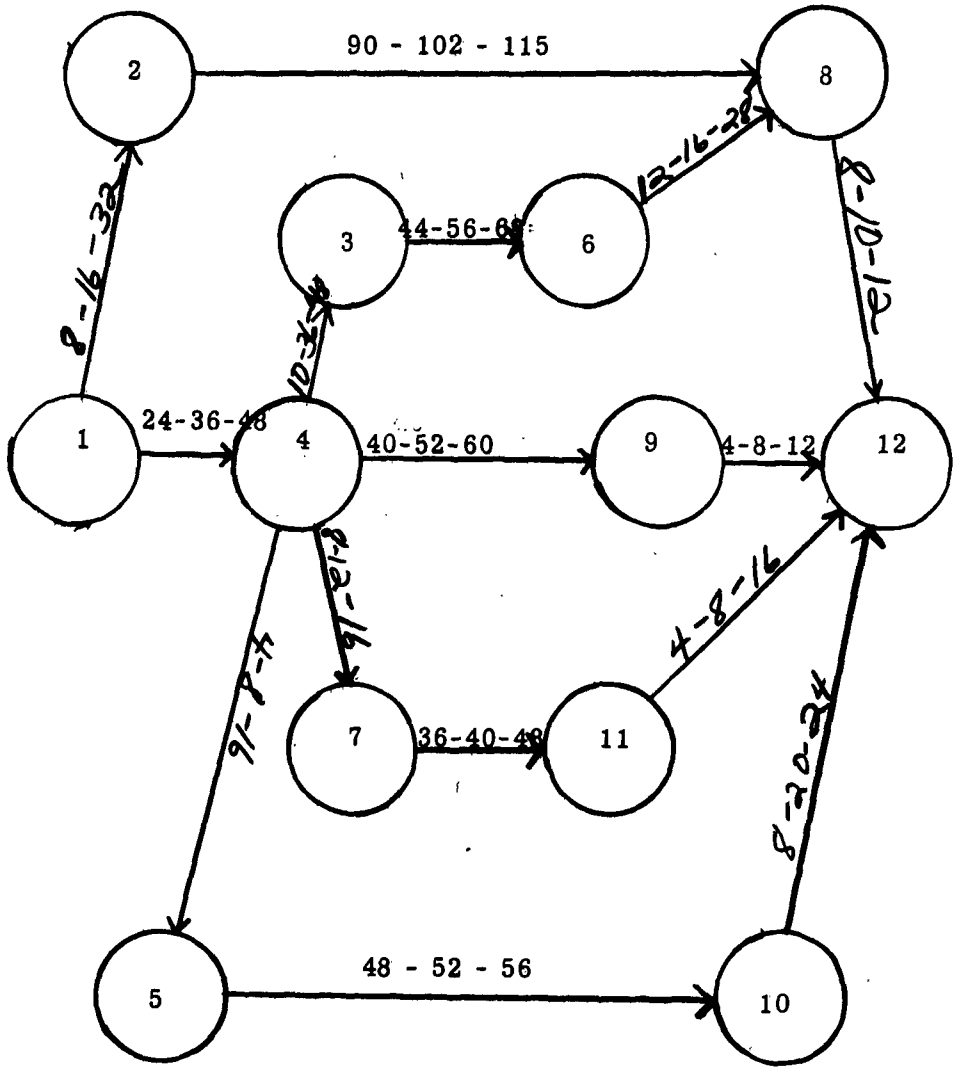
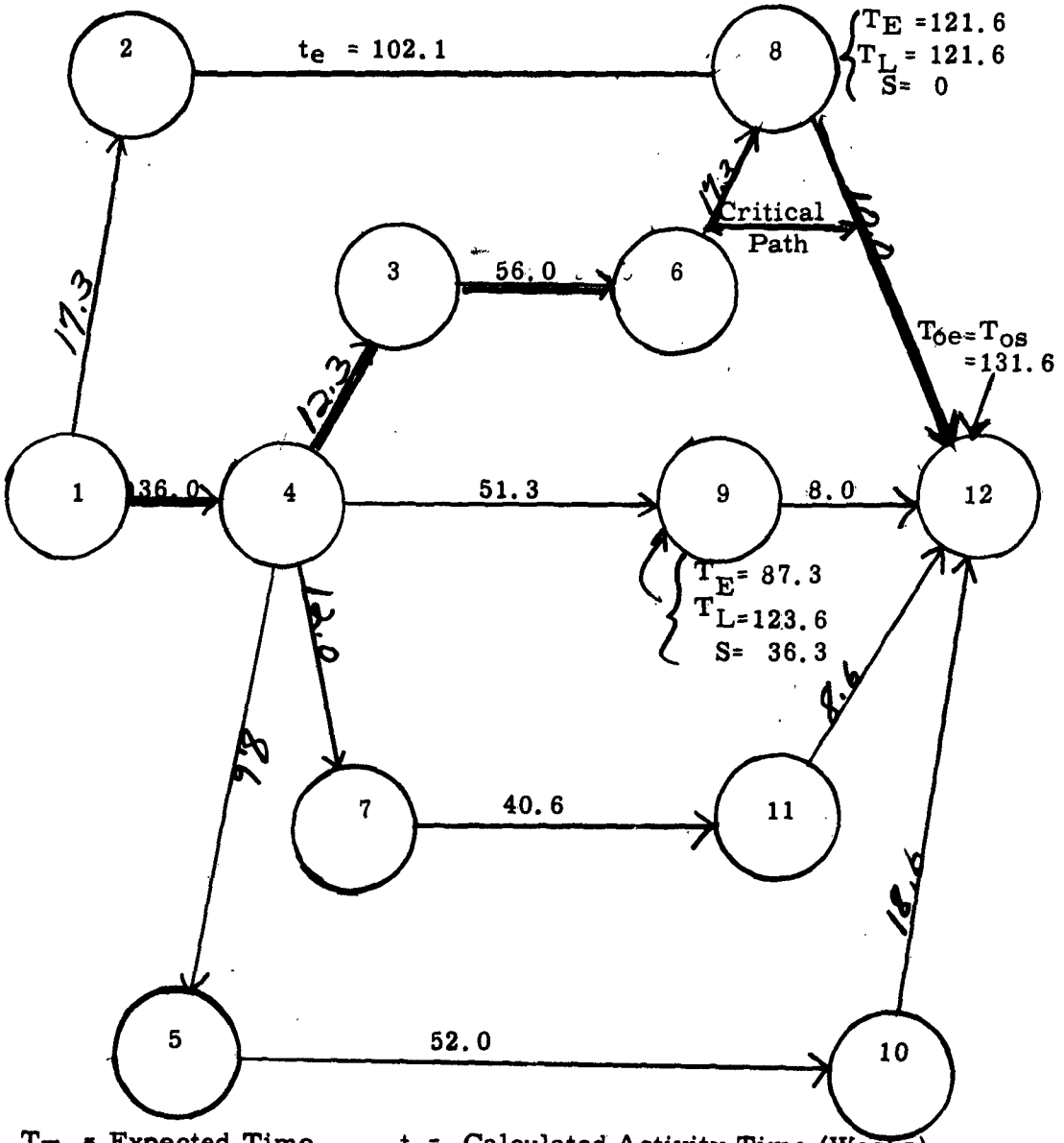


CHART 5

EVENTS -ACTIVITIES



T_E = Expected Time
T_L = Latest Time
S = Slack

t_e= Calculated Activity Time (Weeks)
T_{oe} = Expected Time End Objective
T_{os} = Scheduled Time End Objective

THE ENGINEERING OF MEDICAL CONSTRUCTION

Colonel Jack C. Carmichael
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Office of the Surgeon General
Headquarters USAF

All of you have been or will be involved, sooner or later, to some degree in medical construction. I, as a Professional Engineer in the career field of Sanitary and Industrial Health Engineering, and perhaps as some of you will be, am now assigned full time duty in this area of activity. Let us first consider the "what" and "why" of medical construction, then we'll talk about the engineering aspects. The "what" of medical construction are all the fine new Hospitals, Dispensaries, Dental Clinics, Ambulance Garages, Medical Material Warehouses, Food Inspection Facilities, Medical Schools and Research Facilities now in operation at many Air Force Bases. It was not always thus. When the Air Force became a separate service in 1949, we had little if any new medical facilities, most were World War II temporary type structures. Since 1949, 45 new Hospitals have been constructed as well as many other types of medical facilities. As of 1 July 1962, there are either under construction or in design 16 Composite Medical Facilities (CMF), 5 CMF Additions, 5 Dispensaries, 2 Dispensary Additions, 5 Dental Clinics, 3 Dental Clinic Additions, 10 Schools, Research and other non-patient treatment type buildings. Notwithstanding, the Air Force medical service is still operating over 30 temporary World War II Hospitals in the Continental U.S. This coupled with the rapid changes in medicine and Air Force missions could require from 10 to 20 years to satisfy projected requirements for medical construction at the present rate of construction progress. This represents a tremendous quantity of construction completed, underway or projected. Note the change in name from Hospital to Composite Medical Facility. This is more than a play on words. We now include the total medical capacity into one facility.

The "why" of this construction, is simply that the Air Force must replace outmoded, worn out temporary type medical buildings and build new facilities to meet new missions. All new construction will incorporate current criteria to meet the new type operations. In addition to the new facilities cited, the medical service is also involved in a program to modernize existing medical facilities, both of the temporary type and permanent type construction over five years of age. Construction projects in the modernization program vary from additions costing four (4) million dollars to a single alteration project costing less than a thousand dollars. The engineering involved in the modernization program encompasses all of the criteria for new construction applied with judgment due to the economics of existing configurations and utilities.

Now that we've considered the "what" and "why" of medical construction, let's now get to the "how" of it. A major portion of the "how" can be simply summed up in one word "engineering". According to Webster's new International Dictionary, engineering is defined in two senses, both of which have application here. The more technical definition of engineering is "The art and science by which the mechanical properties of matter are made useful to man." Engineering in the second sense is "The act of maneuvering or contriving as to engineer a bill through Congress." The latter definition brings us to Congress, for without an Act of Congress not one nickel of medical construction or any other Air Force construction could be accomplished. Congress is the final review of all medical construction. An Act of Congress providing funds to construct a new medical facility is the end of a long long road in selling the requirement. The justification selling job requires many engineering judgements concerning the economical feasibility, engineering feasibility, the basic design, [illegible], and required supporting facilities. Once Congress has provided construction funds, there again begins another long trail of design, reviews design, contract awards, construction, construction monitoring, and finally acceptance of the facility. The engineering in this procedure indeed includes both definitions. The foregoing of course, is an extremely simplified version of the long complex programming cycles for the military construction program which involves three overlapping fiscal years. The detailed breakdown, or explanation of this process, would require a great deal more time than we have available today.

Now to consider "who" actually does this engineering and what are some of the functions they perform. First it must be pointed out, in all fairness, that medical construction does involve contributions from many professions with the engineer acting as the "Quarter Back." It is truly a team effort. I will confine this talk to the engineering aspects and specifically who the engineers are and what they do. Starting at Base level, where the initial action on all medical construction must start, the first engineers encountered are those in the Base Civil Engineers's office. The Base Medical Director starts the ball rolling by conceiving a medical construction project and preparing justification for it. This information is given to the Base Civil Engineer who uses it to prepare a project document which includes the justification of the project, a brief description of what's to be done, the scope or floor area, probable cost, and the probable cost for supporting facilities, such as roads, parking areas, utilities and site clearance. The project document is assembled with all the other project documents of that Base, forwarded through Civil Engineering channels to the Directorate of Civil Engineering, Hq USAF, who is charged with responsibility for accomplishing Air Force construction. The medical items are reviewed and revised by the Office of the Surgeon General, Facilities Division. The Director of Civil Engineering includes these

revised projects in the total Air Force construction package and presents it to the Department of Defense and Bureau of the Budget. The medical projects are defended by the Facilities Division in all reviews within the Air Force. Office Secretary of Defense, Bureau of the Budget and Congress.

The Surgeon General employs his own engineering staff to actively coordinate the medical portion of the Military Construction Program at every level of this long rocky trail to Congress. The agency of the Air Force Surgeon General which has been charged with responsibility for this coordination is the Facilities Division, headed by a professional engineer. The Facilities Division has a staff of 46 people of which 22 are engineers and architects. Of these 22 people, 13 are engineer officers classified as Sanitary and Industrial Hygiene Engineers. Twenty-five (25) officers of the Facilities Division staff are assigned to one of 8 Area Medical Construction Liaison Offices. The Director of Civil Engineering also has a number of field offices which are the Regional Civil Engineer Offices. Each of the Area Medical Construction Liaison Officers are assigned to cover one or more of the Regional Civil Engineer Offices and are generally provided office space by the Regional Civil Engineer. The MCLO provides assistance and consultation including engineering architectural services to the Air Force Bases and major commands, in the preparation of the medical items in the Military Construction Program. When new construction is approved, the Regional Civil Engineer is the construction manager and is the Air Force point of contact with the construction agency. The construction agency may either be the Army Corps of Engineers, the Navy Bureau of Yards and Docks, and in some exceptional cases, the Air Force itself. The Area Medical Construction Liaison Officer coordinates the medical portion of this activity.

The Area MCLO has another liaison function which the Regional Civil Engineer is not concerned with. This function involves coordination and consultation on medical construction projects in the Operations and Maintenance, O&M, program as defined in AFR 85-6. Time does not permit to fully elucidate on the complex ground rules governing the programming of O&M projects. Suffice to say, that most projects involving alteration, modification or new construction are in the O&M program if the project cost is less than $25,000. The Base Civil Engineer is the construction agency for O&M projects. Medical O&M projects have an additional programming requirement not required of non-medical projects. All medical O&M projects involving alteration, modification and/or new construction costing over $10,000 require administrative and functional review by the Office of the Surgeon General, Facilities Division, prior to approval within the normal O&M programming cycle. It is for the over $10,000 O&M project that the Area MCLO provides the greatest service to the major command medical services. Through the Area MCLO, the Base Medical Director can be reasonably assured that a project submitted to the Office

of the Surgeon General for review will comply with current Office of the Surgeon General requirements and criteria.

Finally, we get to the last but not least group of engineers that are sometimes involved in the medical construction program. This group of engineers are you, the Base and Command level Sanitary and Industrial Hygiene Engineers. Very wise is the Base Medical Director or Command Surgeon, that utilizes the engineering talents of his assigned Sanitary and Industrial Hygiene Engineers to assist in medical construction, both in new construction and Operation and Maintenance areas. The Facilities Division exercises a continuing effort to encourage all Sanitary and Industrial Hygiene Engineers to be active in this area. Furthermore, the prescribed duties and functions of Sanitary and Industrial Hygiene Engineering is also an essential requirement in medical construction, such as the investigation of Hospital illumination, water supply, waste disposal, radiation hazards, toxic material hazards, ventilation and cross infection. Purely from a Sanitary and Industrial Hygiene point of view this is an essential requirement which I'm afraid has sometimes been neglected in the past.

I wish now to briefly summarize the more important engineering contributions that have been made or are now being worked on by engineers in the Facilities Division. One of the more important contributions has been the engineering approach to planning and functional design of an Air Force medical facility. In years past, the Air Force was limited to the use of a standard design and/ or a fixed total scope or floor area related to the number of beds for each of the Hospitals proposed for construction. Under these conditions, the Air Force soon found itself with Hospitals of a design that did not fulfill the needs of current Air Force medical practice. Consequently, the engineers and architects in the Facilities Division began an intensive study on what the requirements were in terms of scope and functional design of a Composite Medical Facility. These requirements are based on population served, workload and the type of medical treatment the workload consisted of. A series of planning guides eventually evolved. These guides are the "Basis for Design," "Program for Design" and "Space Planning Criteria." Data establishing the number of work stations required in each functional element, based on the projected medical requirements for a particular base, are presented in the "Basis for Design." This document correlates workloads to military strength and translates workloads to work stations. The "Program for Design" adds all required support areas to these work stations and thus establishes the space (scope) necessary to perform the projected medical requirements established in the "Basis for Design." The "Space Planning Criteria" is used in developing the Program for Design. Space criteria shown reflects current requirements and specifically those which vary with size and/or workload of a medical facility. The scope requirements for the CMF functional elements developed in the Program for Design are then drawn up in a plan to show

functional element space relationships to each other. This plan is called a "Diagrammatic Program." The "Program for Design" and "Diagrammatic Program" thus describes in a very concise and compat manner any medical facility project included in a Military Construction Program. These documents serve the tremendously important function of providing Congress, Department of Defense, Bureau of the Budget, and the Air Force a means of evaluating the justification for medical construction projects. In other words, it allows them to see what the Air Force expects to get for the dollars requested. Once a medical project is approved, these documents then inform the construction agency exactly what the Medical Service wants designed and constructed. To date, these documents have been fully accepted by all review and construction agencies. Many other agencies in and out of government are now looking to the Air Force for consultation in design of new hospitals.

However, the engineers and architects in the Facilities Division are not resting on their laurels. The basis of design and pr. grams for design are constantly being re-evaluated, edited, refined and revalidated. In addition, we are working up supplements to these documents. One will give better guidance in the selection and design of equipment that go in medical facilities. Equipment guidance covers specifications, functions, utilities, space, floor loading, ventilation and any other engineering design factor pertaining to installed medical equipment. Another will provide guidance on the selection of finishes within our medical facilities. We are looking for finishes that are economical, sanitary and durable. There has been a tremendous influx of finishing materials on the market in recent years, as in, flooring, ceilings, wall coverings, paints, metal finishes, concrete finishes and ad infinitum. Eventually, we will have a document which provides guidance on finishes for various uses, under various circumstances and in various climates and for various costs.

Carrying the above mentioned planning guides to their logical conclusion, a series of documents are being developed called "Element Studies." Each of these documents provide a total planning guide for each functional element required in a medical facility. For example, the "Element Study" for "Urological Suite" establishes data on scope, floor plan, installed equipment, utility service, relative location with respect to other functional elements, and architectural features peculiar to that element. These requirements are scaled in accord with workload. Then ultimately, the program for design and diagrammatic program can be formulate by the building block assembly of the appropriate date provided by the "Element Study."

In addition to new construction, the above planning guides are also effectively applied to evaluation of existing medical facilities. These

evaluations have been formalized as the "Utilization Plan." Eventually, "Utilization Plans" for all major medical facilities, both temporary and permanent type construction, will be accomplished. The plan will reflect all facility requirements for a 5 year period, each plan to be revalidated annually. The "Utilization Plan" to date has proven to be an excellent management tool for the programming of MCP and O&M medical projects. In essense, the "Utilization Plan" determines if a medical facility requires additional scope and/or modification to satisfy the criteria of the "Basis for Design," "Space Planning Criteria" and eventually "Element Studies". The "Utilization Plan" developed in the same manner as the "Program for Design" and "Diagrammatic Program" provides the guidance necessary to program additions and/or modification projects to eliminate functional deficiencies. The "Utilization Plan" may be initiated by the Facilities Division or at any level of command. Surveys for background data are conducted by the Area Medical Construction Liaison Office. These surveys are performed with the active cooperation of the Base medical service. Sanitary and Industrial Hygiene Engineers have and can perform a signal service in this respect. The Area MCLO in consultation with the Base Medical Director then prepares recommendations for use in the development of the "Utilization Plan" by the Facilities Division. The completed "Utilization Plan" is then forwarded to the Area MCLO for presentation to the using command for programming both MCP and O&M projects. This is the process of modernization to comply with current practice of medicine to high standards of medical treatment.

Lastly, an engineer assigned as a Medical Construction Liaison Officer makes a major contribution in monitoring and coordination of medical construction in progress. There are no perfect plans and specifications, no perfect contractors or no perfect construction agencies. In the process of constructing a large CMF numerous conflicts arise on the job in the interpretation of specifications and drawings. Many of these conflicts involve questions of medical opinion. An engineer as a Project MCLO, or located in the office of the Area Medical Construction Liaison officer, translates professional medical opinion into engineering terms and conversely the problems of the contractor or construction agency into terms understandable to the medical profession. That is the performance of liaison duty in its true sense. I wish time would permit to really get down to specifics on some of the engineering problems that we encounter in our everyday duties. I think that you, engineers would find this duty to be a real challenge as I have.

ENVIRONMENTAL CONTROL IN MEDICAL FACILITIES

Mr. Clinton C. Boyd, Mechanical Engineer
Office of the Surgeon General, USAF

There are many things that make up our environment, in fact; everything around us makes up our environment. Factors that affect our senses are such things as light, temperature, sound, color, odors, or anything that can be detected by our eyes, ears, nose, or feeling. Other factors affect us psychologically, such as: where we live, where we work, the people around us, our wives, our children, and we could go on and on discussing our psychological environment. There are still other factors that affect our health and well being, such as the air we breathe, the roof over our heads (protection from the natural elements), the food we eat, the water we drink, or anything else we might drink.

We cannot control all of the factors which make up our environment, but it isn't necessary to control all of them. We can cause a noticeable change in feeling and behavior of people by controlling only a few factors - sometimes only one. For instance, if only the temperature of this room were raised 5 to 10 degrees, no doubt we would become uncomfortable and drowsy. (You fellows down here in front would probably go to sleep too.) On the other hand, let's imagine a few other changes in our environment here and leave the temperature alone. Let's dim the lights, place a bar there in the back, bring in a dozen pretty girls dressed in bunny costumes, and then put a female singer behind this microphone - does anyone doubt that there would be a drastic change in the behavior of this group? (Nobody would care what the temperature was.)

The only point that has been made up to now is that environmental control is a very broad and complex subject. So for this discussion we will have to narrow down a bit to the environment we hope to achieve in medical facilities.

First, we do not want to minimize comfort. We all know that comfort accelerates patient recovery and improves personnel efficiency. With the advanced development in the science of air conditioning there is no great problem here (except finding the money to pay for it). However, now that air conditioning has come into the modern medical facility and is here to stay, it has also brought with it some problems which we will discuss later.

For the psychological well being of patients and personnel, we design many features into a medical facility, such as: sound systems, colors selection, lounges and recreational facilities. Every effort is made by the hospital staff to make the environment as pleasant as possible.

There are hazardous areas within a medical facility which we have not mentioned until now. By hazardous areas, I am referring to areas where flammable anesthetics are used. Environmental control and safety precautions for such areas are covered in various codes, particularly NFPA Codes. We will not go into details here, but I would like to make this point. Whenever you gentlemen have a problem which involves an operating room or some other hazardous area, find out what the safety codes and and stick to them. Do not sit in judgment on these codes even though you may think some of the requirements are excessive. Any time you compromise safety, you are gambling with life -- not always your life, but someone else's. An explosion in an operating room is not a very pleasant experience.

Now that we have touched on comfort, psychology, and safety, let's narrow our subject down once again and talk about the health aspects of hospital environment. This brings us to the universal problem of air-borne infections -- how they spread and what we can do to retard their spread.

If we had clean air (here I mean the ultimate) and could keep it clean as it passes through our facilities, the spread of infections by air movement would be no problem. Unfortunately, this is not the case. All air contains to a varying degree, dust particles, moisture, and other microscopic fragments, all of which are vehicles for spreading infections. Further, as air is put in motion, it tends to pick up more particles from the floor, furniture, and people. The quantity of pick up increases with velocity. Now you can see that we are beginning to get into trouble with our air conditioning. I do not want to get into technical details, but I would like to point out some features or faults to watch for in hospital air conditioning and ventilation systems whether they be new design or existing facilities.

Ventilation or outside air: The ventilation rate of a medical facility should be liberal whether the facility is air conditioned or not. Outside air not only dilutes odors but dilutes air-borne contaminates. Certain areas in a hospital that are highly susceptible to contamination require 100% outside air. In other words, the air is brought in from the outside, and as it passes through the area, it picks up contaminated particles and carries them out through the exhaust system.

Filtration is very important in hospital air systems. Outside air is normally free of pathogens, but not necessarily free of dust and other particles. Efficient filtration of outside air is essential because this eliminates the vehicles for spreading infections. Likewise, filtration of recirculated air is just as essential. Watch for the quality of maintenance of filters. I visited one hospital and asked if they were having any trouble with the electrostatic filters in the surgery suite. The reply I received was: "Oh, we shut those thing off a couple of months ago because the dust would build up on them and start flaking off." At another hospital I

visited, the maintenance personnel were servicing their filters at an acceptable frequency, something like every two weeks, but they were confused as to why dust was building up in the duct work. Upon investigation I found that they did not have any extra filters so they were removing the filters, cleaning them, and then replacing them. This process would take from two to four hours because the filters were carried to the base shops for cleaning. In the meantime the fans were left running without filters. It was not too hard to figure out why their duct work and building were getting dirty.

Proper zoning can be an aid in keeping air-borne contaminates within a confined area while improper zoning will have the opposite effect. Proper zoning applies to the return air system as well as the supply. Often you will find air systems that have been carefully zoned for temperature control but little or no consideration has been given to the problem of cross contamination or spread of infections. You will find such things as the entire building connected to a common return system, or the Air Force Clinic on a common zone with central sterile supply; or the administrative wing on the same zone with maternity ward; or air being recirculated from the soiled linen storage.

Air movement within hospital spaces is another critical factor. The natural tendency is for dust particles and droplets to settle to the floor or settle on objects in the room. If the air velocity is too great, turbulence is set up which keeps particles in suspension and carries them to other rooms. Turbulence not only keeps particles in suspension, but it causes contaminates to be picked up from the floor and other objects in the room. Air movement should not exceed 35 feet per minute in any area of a medical facility and should be kept below 25 feet per minute in critical areas, such as operating rooms, nurseries, etc.

Cross contamination can occur outside the building. Watch out for short circuits between exhaust and air intakes. This consideration is often overlooked in design of new facilities but more often brought about over the years by a number of "piecemeal" modification projects. So when you add that exhaust to the laboratory, be careful that you do not blow it into the intake for surgery.

In the design and construction of new facilities, the type of equipment installed should recieve careful consideration. Equipment should be selected that lends itself to easy and convenient cleaning. Of course, in existing facilities we are "stuck" with what we have and we have to make the best of it.

Air conditioning and ventilating systems are not the only villains in the spread of infections. Such things as foot traffic, soiled linen handling, contaminated carts, elevators, and over-all laxness in housekeeping are probably the worst offenders in this problem. At times I am called out to Air Force hospitals where they are having trouble controlling the spread of infections. My prime mission on such calls is to survey the air conditioning system to determine how it may be aggravating the problem. I nearly always find some faults in the air conditioning system, but during these surveys I also find other things. I have found clean linens and supplies going into wards on the same carts that brought soiled linens and utensils from the wards. I have been in facilities where the housekeeping in public areas consisted of an airman dragging a wet mop down the corridor on Monday, Wednesday, and Friday - on Tuesday he has squadron duties and he goes out for tennis on Thursday. It holds true to form that when you find this kind of laxness in the public areas, you will also find it in surgery and other areas. During a survey of one hospital, I was asked specifically to check the exhaust system in the soiled linen storage. When I went downstairs I found the soiled linen room empty and the exhaust system working as it should. I also observed something else that will curl your hair. The NCOIC had two or three days accumulation of soiled linen scattered up and down the main basement corridor and elevator lobby and he was busy sorting and counting. When he had finished counting, he placed the linen in bags, closed them tightly, and carefully placed them in one corner of the soiled linen room. Here was a case where accounting and administration were more important than controlling the spread of infections. The irony of this little incident is that at the very moment I was making this observation, the Infectious Disease Committee for this hospital was holding a meeting in the conference room.

I don't know of any single problem today that haunts hospital management more than the constant threat of total contamination of their facility, but, Gentlemen, are we really trying to do anything about this problem, or are we just giving it lip service and hoping that we never get caught.

EVALUATION OF PERSONNEL EXPOSURE FROM STRATOSPHERIC FISSION FRAGMENT CONTAMINATION ON AIRCRAFT

Major James L. Dick, Captain Marvin C. Gaske, and Colonel Leo A, Kiley, Jr

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THE RADIATION HAZARD FROM CONTAMINATED AIRCRAFT

J. Laurence Kulp, and J. L. Dicks

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